Allen-Bradley

ControlLogix™ Redundancy System

User Manual

Rockwell Automation

Important User Information

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Throughout this publication, notes may be used to make you aware of safety considerations. The following annotations and their accompanying statements help you to identify a potential hazard, avoid a potential hazard, and recognize the consequences of a potential hazard:

WARNING

Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

ATTENTION

Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss.

IMPORTANT

Identifies information that is critical for successful application and understanding of the product.

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Purpose of this Manual

This manual guides the design, development, and implementation of a redundancy system for a ControlLogix controller.

- Redundancy requires no additional programming and is transparent to any devices connected over the ControlNet™ network.
- When a failure occurs in any of the components in the primary chassis, control switches to a controller in a secondary chassis.
- During the switchover, outputs that are controlled by the highest priority task will experience a bump-less switch over. (i.e., Outputs will not revert to a previous state.)
- Outputs in lower priority tasks *may* experience a change of state.

Who Should Use this Manual

This manual is intended for those individuals who design and develop applications that use ControlLogix controllers, such as:

- software engineers
- control engineers
- application engineers
- instrumentation technicians

When to Use This Manual

Use this manual throughout the life-cycle of a redundancy system:

- design
- installation
- configuration
- testing
- maintenance and troubleshooting

How to Use this Manual

This manual is divided into the basic tasks that you perform during the design, development, and implementation of a ControlLogix redundancy system.

- Each chapter covers a task.
- The tasks are organized in the sequence that you will typically perform them.

As you use this manual, you will see some text that is formatted differently from the rest of the text:

Text that is:	Identifies:	For example:	Means:
Italic	the actual name of an item that you see on your screen or in an example	Right-click *User-Defined* …	Right-click on the item that is named User-Defined.
`courier`	information that you must supply based on your application (a variable)	Right-click *`name_of_program`* …	You must identify the specific program in your application. Typically, it is a name or variable that you have defined.

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Design the System

When to Use this Chapter

Use this chapter to design a redundancy system for a ControlLogix controller

How to Use this Chapter

To design your system:

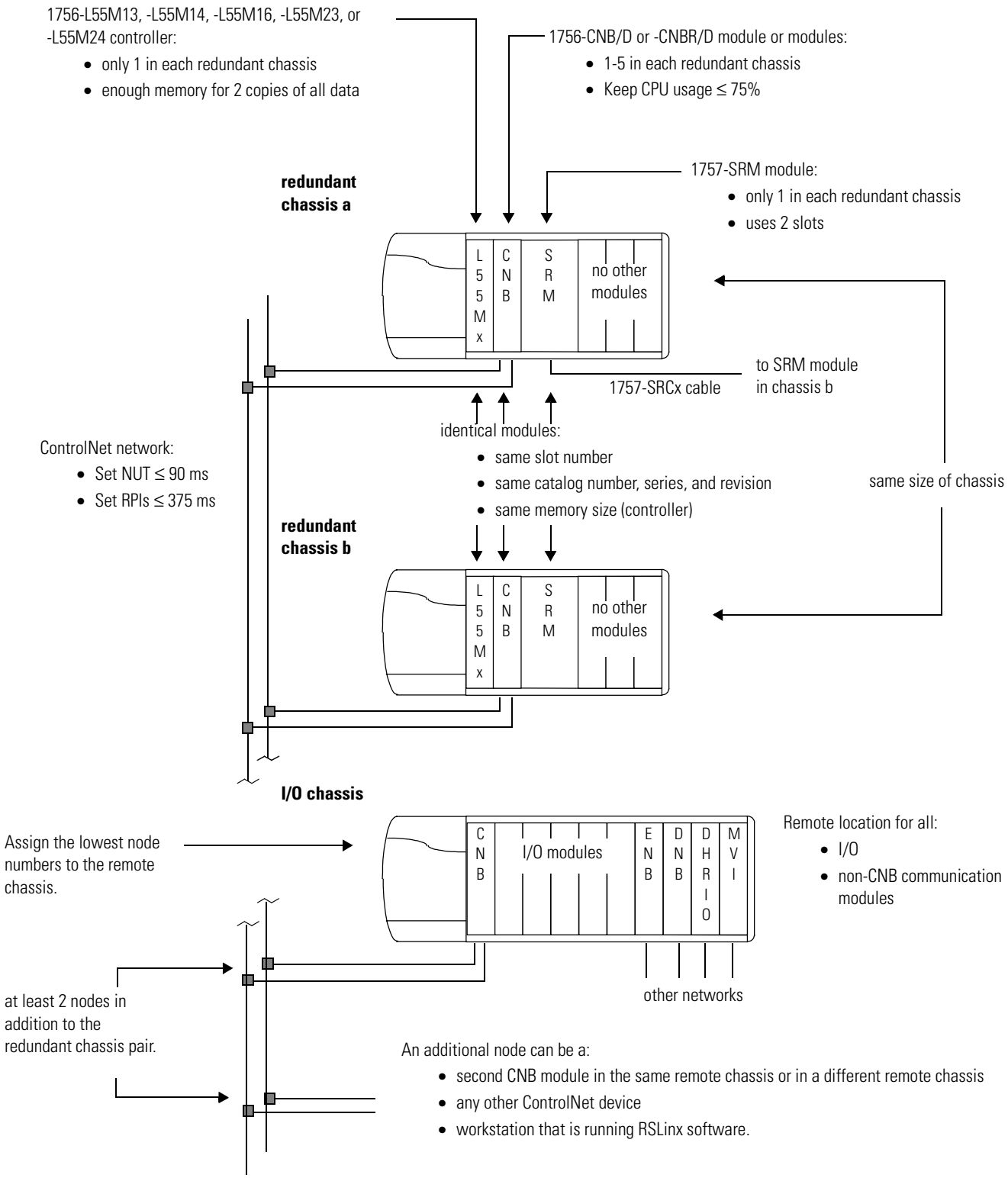
- Select the Hardware
- Check Connection Requirements
- Estimate Scan Time
- Assign ControlNet Addresses
- Develop the Bill of Materials

If you are adding redundancy to an existing system, also see the following section:

- Tips for Adding Redundancy to an Existing System

Select the Hardware

A ControlLogix redundancy system requires the following hardware:


1756-L55M13, -L55M14, -L55M16, -L55M23, or -L55M24 controller:
• only 1 in each redundant chassis
• enough memory for 2 copies of all data
1756-CNB/D or -CNBR/D module or modules:
• 1-5 in each redundant chassis
• Keep CPU usage ≤ 75%
1757-SRM module:
• only 1 in each redundant chassis
• uses 2 slots
redundant chassis a
L55Mx
CNB
SRM
no other modules
to SRM module in chassis b
1757-SRCx cable
identical modules:
• same slot number
• same catalog number, series, and revision
• same memory size (controller)
same size of chassis
ControlNet network:
• Set NUT ≤ 90 ms
• Set RPIs ≤ 375 ms
redundant chassis b
L55Mx
CNB
SRM
no other modules
I/O chassis
Assign the lowest node numbers to the remote chassis.
CNB
I/O modules
ENB
DNB
DHRIO
MVI
Remote location for all:
• I/O
• non-CNB communication modules
other networks
at least 2 nodes in addition to the redundant chassis pair.
An additional node can be a:
• second CNB module in the same remote chassis or in a different remote chassis
• any other ControlNet device
• workstation that is running RSLinx software.

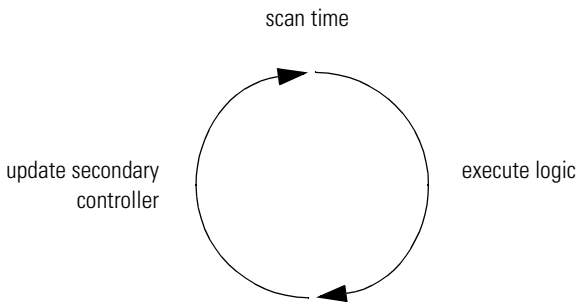
Check Connection Requirements

Make sure that each controller and CNB module in a redundant chassis has available enough connections for redundancy communications. Redundancy communications require the following number of additional connections:

This module:	Uses this many additional connections for redundancy:	Description:
controller	7	2 for the SRM 5 for the partner
CNB	3	2 for the SRM 1 for the partner

Estimate Scan Time

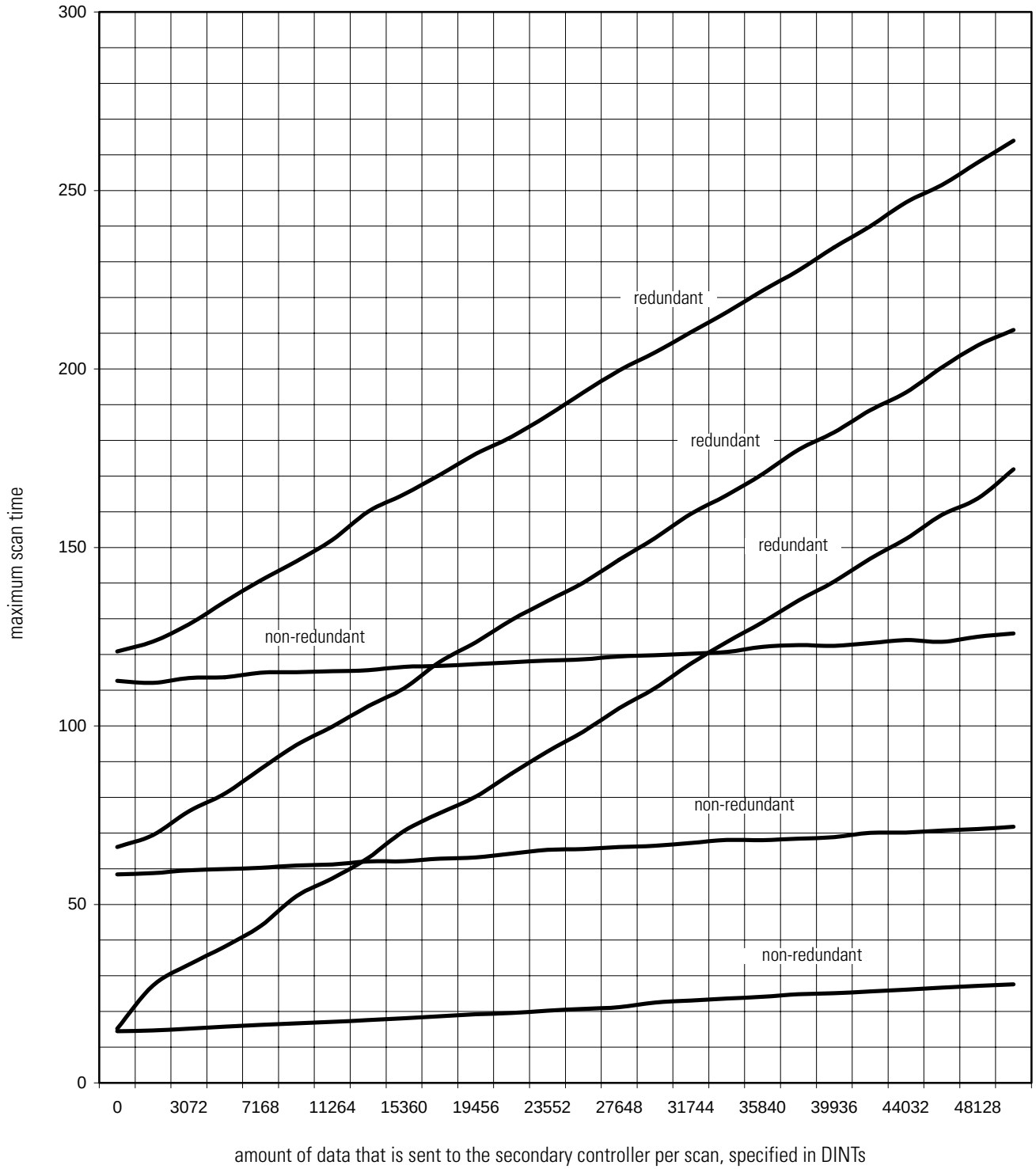
After each scan of the logic, the primary controller sends to the secondary controller the result of any output instruction that executed during the scan.



This increases the scan time of a project when compared to a non-redundant system.

- The amount of increase depends on how much data must be sent to the secondary controller.
- Figure 1.1 on page 1-4 compares the scan times for redundant and non-redundant controllers.

Figure 1.1 The following graph shows the scan time verses data transfer for redundant and non-redundant projects. The curves represent projects with small, medium, and large scan times.



To determine the amount of data that transfers to the secondary controller during a scan, use a GSV instruction to access the REDUNDANCY object (only available for a controller that is configured for redundancy):

For this information:		Get this attribute:
Number of DINTs that were or would have been transferred		LastDataTransferSize
If:	**Then this value is the:**	
a synchronized partner is present	amount of data that was last transferred to the partner, specified in DINTs	
no partner is present	amount of data that would have been last transferred to a synchronized partner, specified in DINTs	
a disqualified partner is present		
Maximum value of the LastDataTransferSize attribute		MaxDataTransferSize

For more information on using the GSV instruction, see "Get System Values" on page 5-1.

To minimize the scan time of your project:

- Use Arrays and User-Defined Data Types
- Execute Instructions Only When Required

Use Arrays and User-Defined Data Types

To update the secondary controller, the primary controller divides its memory into blocks of 256 bytes. Anytime an instruction writes a value, the primary controller sends the entire block that contained the value to the secondary controller.

To minimize scan time, organize your data into arrays and user-defined data types (structures) whenever possible. Arrays and structures provide these advantages:

- Data is more compact. This lets the primary controller send it more quickly to the secondary controller.
- Related data is grouped together.
  - Related data is likely to change at the same time.
  - Since the controller sends data in 256 byte blocks, fewer blocks may be required than if the same amount of data was spread across many individual tags.

To create arrays and user-defined data types, see the *Logix5000 Controllers Common Procedures*, publication 1756-PM001.

Execute Instructions Only When Required

Anytime an instruction writes a value to a tag, even if it is the same value, the primary controller sends the value to the secondary controller. Many instructions write a value to a tag whenever they are scanned.

- Instructions such as OTL, OTU, and many instructions with Destination operands write a value each time the rung-condition-in is true.
- Each execution of the instruction causes the primary controller to send additional data to the secondary controller, even if the data did not change.

  For example, each time the controller executes an ADD instruction, the controller must update the secondary controller This occurs even if the ADD instruction produced the same value as its previous execution.

To minimize scan time, execute instructions only when required, if possible. This reduces the unnecessary update of data, which reduces scan time.

Assign ControlNet Addresses

IMPORTANT

1. Make sure that your network has at least 2 nodes in addition to the redundant chassis pair. An additional node can be a:

   - second CNB module in the same remote chassis or in a different remote chassis
   - any other ControlNet device
   - workstation that is running RSLinx software.

   If your ControlNet network contains only one node other than the redundant chassis pair, that node will drop its connections during a switchover. This may cause the outputs of that node to change state during the switchover.

IMPORTANT

2. Assign the lowest ControlNet addresses to I/O chassis and other remotely-located chassis. (I.e., *Do not* assign the lowest addresses to the redundant chassis pair.)

   If you assign the lowest address to a CNB module in the redundant chassis pair:

   - On a switchover, you may temporarily lose communication with I/O modules, produced tags, and consumed tags.
   - If you remove the CNB module from the primary chassis while chassis power is on, you may temporarily lose communication with I/O modules, produced tags, and consumed tags.
   - If every ControlNet node powers down at the same time (e.g., a plant-wide power loss), you may have to cycle the power to the primary chassis to restore communication.

3. Allocate two consecutive ControlNet addresses for the pair of redundant chassis (e.g., nodes 3 and 4). Use Table 1.1 on page 1-8 to record your network addresses.
   - The 1756-CNB/D or -CNBR/D modules in the pair of redundant chassis share two ControlNet addresses.
   - The matching 1756-CNB/D or -CNBR/D module in the secondary chassis will automatically use the primary CNB module's address plus one.
   - On switchover, the primary and secondary CNB modules swap addresses.
   - Do not configure any other device on the ControlNet network for either of these addresses. For example, if you allocated nodes 3 and 4 for the redundant chassis, then no other device should use those node numbers.
   - If each redundant chassis has multiple CNB modules, assign a pair of node numbers for each pair of CNB modules (one in each chassis).

   Use the following worksheet to record the slot number and node numbers for each pair of CNB modules:

Table 1.1 Slot and node numbers for 1756-CNB/D or -CNBR/D modules

Pair of CNB modules (one in each redundant chassis)	Slot and node numbers		
	Slot #	Primary node #	Secondary node # (primary node # + 1)
1st pair of CNB modules			
2nd pair of CNB modules			
3rd pair of CNB modules			
4th pair of CNB modules			
5th pair of CNB modules			

Develop the Bill of Materials

The ControlLogix redundancy system requires the following hardware for your controllers:

Table 1.2 Bill of Materials for the Redundant Controller Chassis

✔	Qty	Item	Cat number
	2	chassis	1756-A4, -A7, -A10, -A13, or -A17
	2	power supply	1756-PA72, -PB72, -PA75, or -PB75
	2	controller	1756-L55M13, -L55M14, -L55M16, -L55M23, or -L55M24
	2	ControlNet bridge module	1756-CNB/D or -CNBR/D
	2	redundancy module	1757-SRM
	1	fiber optic cable	1757-SRC1, -SRC3, or -SRC10

You also need the following materials. The actual items depend on the design and lay-out of your system.

Table 1.3 Additional Materials

✔	Qty	Item	Cat number	Notes
		chassis or DIN rails	as required for your I/O modules	For ControlLogix chassis, redundant power supplies are available as an option: • For a redundant power supply kit, order catalog number 1756-PAR or 1756-PBR. • Each kit contains two redundant power supplies, cable, and adapter.
		ControlNet adapters	as required for your chassis or DIN rail	• You need an adapter for each remote chassis or rail. • If you are using a redundant ControlNet network, order the redundant (R) version of each adapter. • You need at least two ControlNet nodes in addition to the CNB modules in the redundant chassis pair.
		ControlNet tap	1786-TPS, -TPR, -TPYS, or -TPYR	If you are using a redundant ControlNet network, you need two taps for each device on your ControlNet network.
		RG-6 coaxial cable	1786-RG6 or -RG6F	
		terminator	1786-XT	You need 2 terminators for each ControlNet segment.
		RSLogix 5000 software	9324-RLD300, -RLD300NXENE, or -RLD700	• Use revision 8.51 or later. • All three catalog numbers include RSLinx Lite software. (Use RSLinx revision 2.30.01 or later.) • 9324-RLD300NXENE, and -RLD700 include RSNetworx for ControlNet software. • 9324-RLD700 lets you program in both ladder instructions and function blocks.
		RSLinx Lite software		
		RSNetWorx for ControlNet	9357-CNETL3	revision 3.00

Tips for Adding Redundancy to an Existing System

If you are adding redundancy to an existing system, follow these suggestions:

- If you change the node number of a CNB module, you may affect messages, tags, or listen-only connections in other devices. Choose node numbers that have the least impact on existing communications.
- If your existing system contains local I/O modules, you still need two additional chassis.
  - A redundant system can use only I/O that is in a remote chassis (i.e., not in the same chassis as the controller). Refer to Install the Remote Chassis or Rails on page 2-7.
  - We recommend that you move the existing 1756-L55Mxx controller from the original chassis and place it in a redundant chassis.

Install the System

When to Use this Chapter

Use this chapter to install the hardware of your ControlLogix redundancy system.

Before You Begin

This chapter provides the sequence of tasks and the critical actions for the successful installation of your ControlLogix redundancy system. It *does not* replace the installation instructions for the components of the system.

- In addition to this manual, use the following installation instructions as you install your system:

Install this component:	According to this publication:
1756-A4, -A7, -A10, -A13, or -A17 chassis	*ControlLogix Chassis Installation Instructions*, publication 1756-IN080
1756-PA72 or -PB72 power supply	*ControlLogix Power Supplies Installation Instructions*, publication 1756-5.67
1756-PA75 or -PB75 power supply	*ControlLogix Power Supplies Installation Instructions*, publication 1756-5.78
1756-L55M13, -L55M14, or -L55M16 controller	*ControlLogix Controller and Memory Board Installation Instructions*, publication 1756-IN101
1756-CNB/D or -CNBR/D module	*ControlLogix ControlNet Bridge Installation Instructions*, publication 1756-IN571
1757-SRM module	*ProcessLogix/ControlLogix System Redundancy Module Installation Instructions*, publication 1757-IN092

- The installation instructions for each component provide the following information, which is required for your system:
  - detailed installation steps
  - safety considerations
  - enclosure requirements
  - specifications
  - hazardous location information

Before you install the system, review the following guidelines for safe handling of ControlLogix components:

WARNING

When you insert or remove a module while backplane power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

Repeated electrical arcing causes excessive wear to contacts on both a module and its mating connector. Worn contacts may create electrical resistance that can affect module operation.

ATTENTION

Preventing Electrostatic Discharge

This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

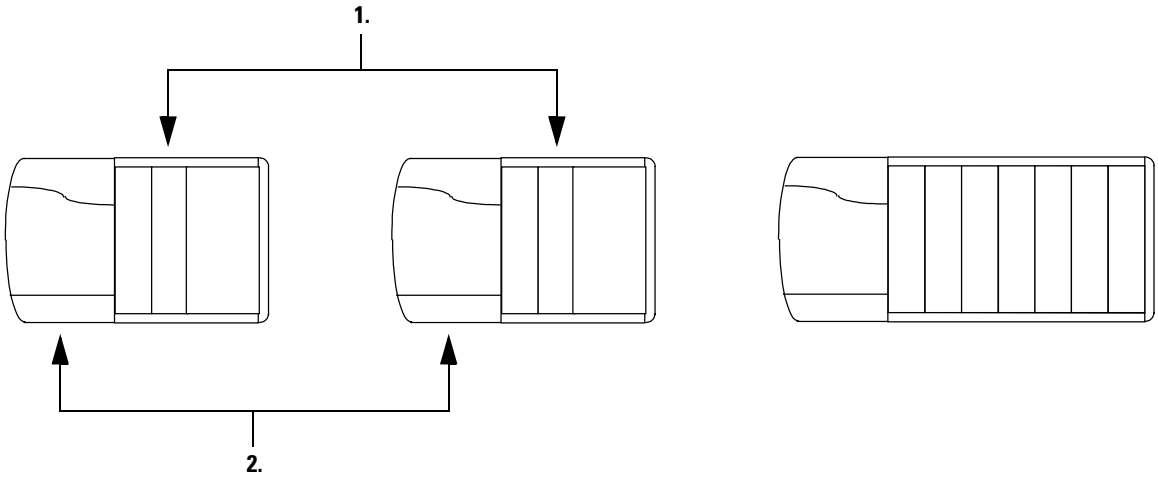
- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- If available, use a static-safe workstation.
- When not in use, store the equipment in appropriate static-safe packaging.

How to Use this Chapter

To install the system:

- Install the Chassis for the Controllers
- Install Modules in the First Redundant Chassis
- Install Modules in the Second Redundant Chassis
- Install the Remote Chassis or Rails

Install the Chassis for the Controllers



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1. Install the two ControlLogix chassis that will contain the controllers (i.e., the redundant chassis):

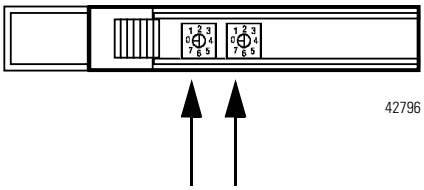
- Place the chassis within the length of your 1757-SRCx cable.
- Install each chassis according to the *ControlLogix Chassis Installation Instructions*, publication 1756-IN080.
- If you are converting an existing system that contains local I/O modules, you still need two additional chassis. A redundant system can use only remote I/O.

2. For each chassis, install a ControlLogix power supply according to the corresponding installation instructions:

Install this power supply:	According to this publication:
1756-PA72	*ControlLogix Power Supplies Installation Instructions*, publication 1756-5.67
1756-PB72	
1756-PA75	*ControlLogix Power Supplies Installation Instructions*, publication 1756-5.78
1756-PB75	

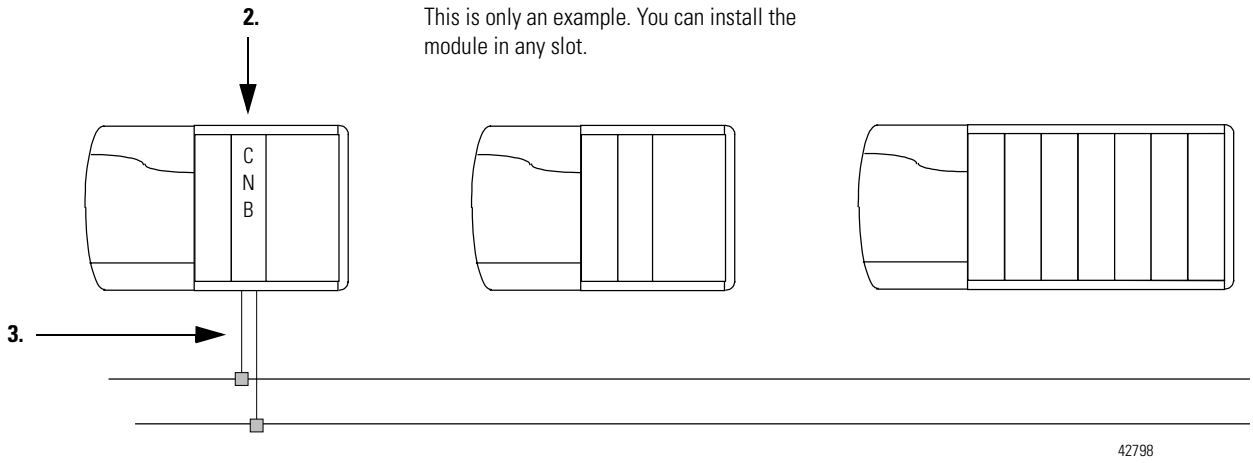
Install Modules in the First Redundant Chassis

IMPORTANT Set the rotary switches of the 1756-CNB/D or -CNBR/D modules for both redundant chassis to the same node address.



1. Set the rotary switches of each of the 1756-CNB/D or -CNBR/D modules to the primary node number from Table 1.1 on page 1-8.

   For example, if you allocated nodes 3 and 4 for the redundant chassis, set both CNB modules to node 3.



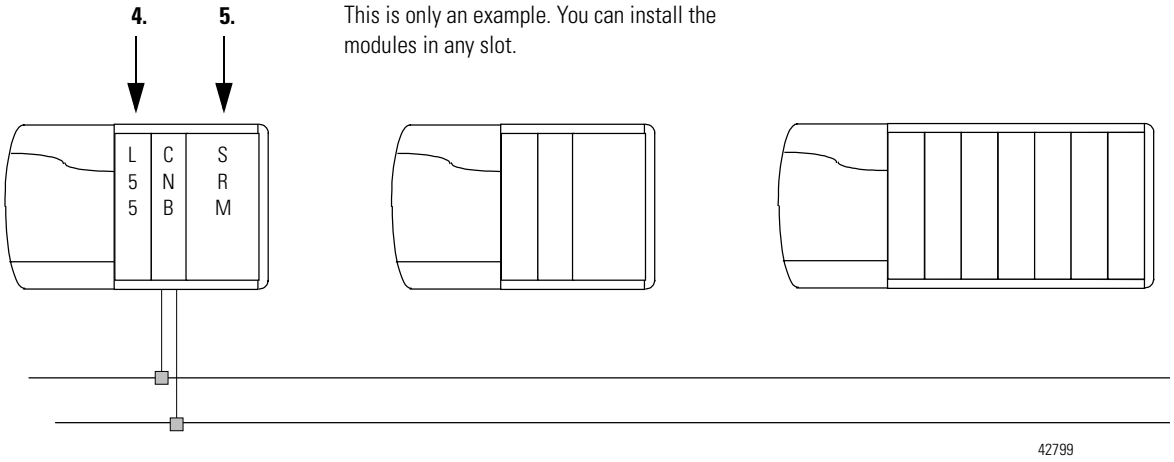
2. Install a 1756-CNB/D or -CNBR/D module. See *ControlLogix ControlNet Bridge Installation Instructions*, publication 1756-IN571.

WARNING

If you connect or disconnect the ControlNet cable with power applied to this module or any device on the network, an electrical arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding.

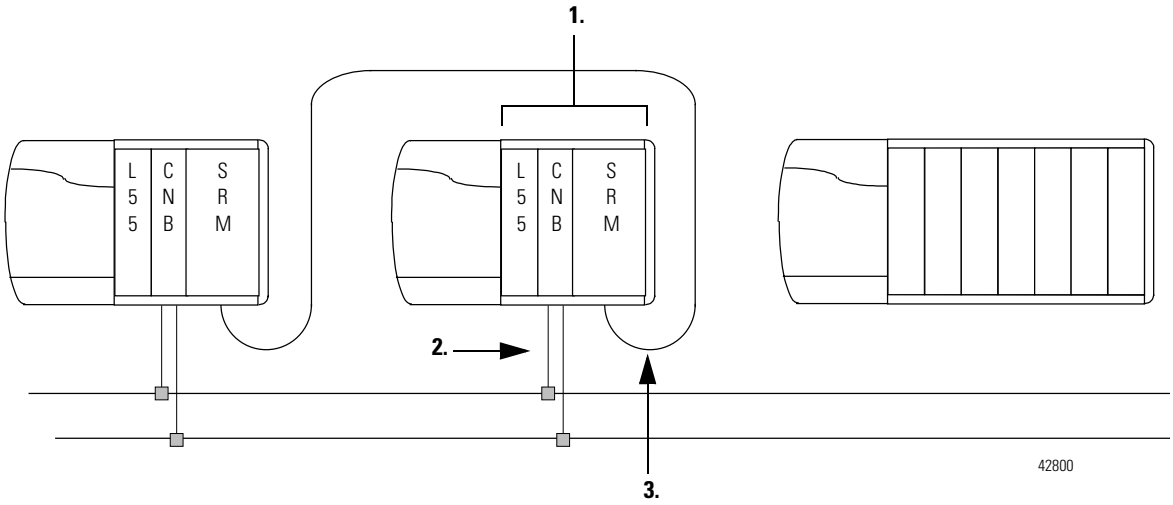
3. Connect the CNB module to the ControlNet network.



4. Install the 1756-L55Mxx controller. See *ControlLogix Controller and Memory Board Installation Instructions*, publication 1756-IN101.

5. Install the 1757-SRM module. See *ProcessLogix/ControlLogix System Redundancy Module Installation Instructions*, publication 1757-IN092.

Install Modules in the Second Redundant Chassis



IMPORTANT

- The modules in each redundant chassis must match each other slot-by-slot.
- Set the rotary switches of the 1756-CNB/D or -CNBR/D modules for both redundant chassis to the same node address.

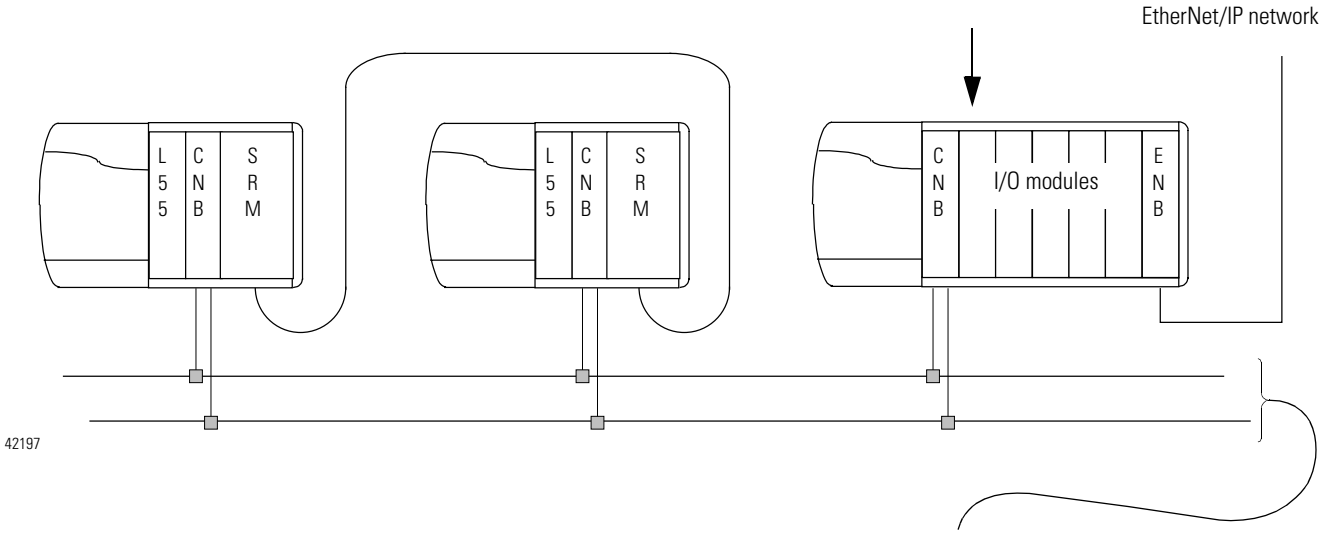
1. For each module in the first redundant chassis, install an identical module into the same slot of the second redundant chassis.

2. Connect the CNB module (s) to the ControlNet network.

3. Connect the 1757-SRC1, -SRC3, or -SRC10 fiber optic cable to the 1757-SRM modules.

Install the Remote Chassis or Rails

You must install all I/O modules and additional types of communication modules in remote chassis or on DIN rails. The following example shows a remote 1756 chassis. You can use any type of chassis or device that you can connect to the ControlNet network.



You must have at least one other node in addition to the redundant chassis pair *and* the remote I/O chassis. See "Select the Hardware" on page 1-2.

IMPORTANT If you connect the workstation to the network via a network access port on a CNB module, use a CNB module in a remote chassis. This lets the workstation stay online with the new primary controller after a switchover.

As you install the chassis, follow these guidelines:

- Do not assign any device to the address of the CNB modules in the redundant chassis plus one.

  For example, if you set the rotary switches of the CNB modules in the redundant chassis to node 1, no other device should use node 2.

- Use a remote chassis for communication modules such as:
  - 1756-ENET or -ENB
  - 1756-DHRIO
  - 1756-MVI
  - 1756-DNB

Notes:

Configure the System

When to Use this Chapter

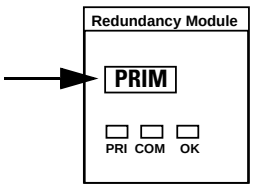
After you have installed your system, use this chapter to configure the system for redundancy.

How to Use this Chapter

To configure the system:

- Flash the Modules
- Synchronize the Controllers
- Configure the Project for the Controllers
- Configure I/O
- Tips for Configuring Your System.

Flash the Modules



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1. Turn on the power to one of the redundant chassis.
2. Wait for the 1757-SRM module to display PRIM.
3. Flash upgrade each module in the chassis with a compatible revision of firmware.
   - See the *ControlFLASH Firmware Upgrade Kit User Manual*, publication 1756-6.5.6.
   - To find the chassis in RSLinx software, use the node number that the CNB module in the chassis displays.
4. Turn off the power to the chassis.
5. Turn on the power to the second redundant chassis.
6. Wait for the 1757-SRM module to display PRIM.
7. Flash upgrade each module in the chassis with a compatible revision of firmware. Use the same revisions that you used for the first redundant chassis.

Synchronize the Controllers

To synchronize the controllers in the redundant chassis pair:

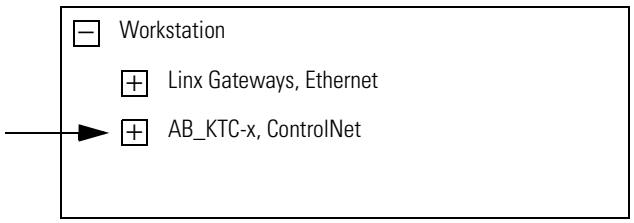
- Select the Auto-Synchronization Option
- Synchronize the Controllers

Select the Auto-Synchronization Option

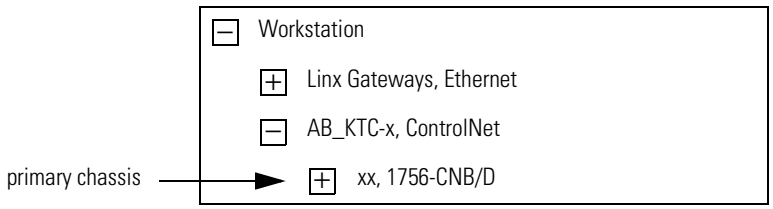
1. Go to RSLinx software.

To expand a network one level, do one of the following:

- Double-click the network.
- Select the network and press the → key.
- Click the + sign.

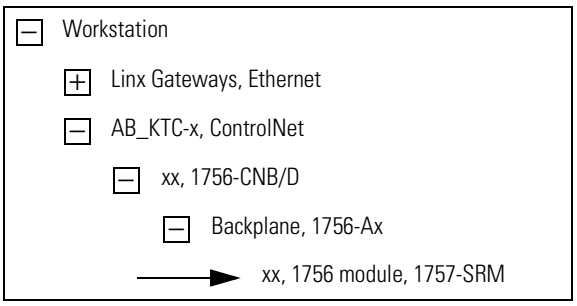


2. Navigate to the CNB module of the primary chassis. The primary chassis uses the node to which its rotary switches are set.



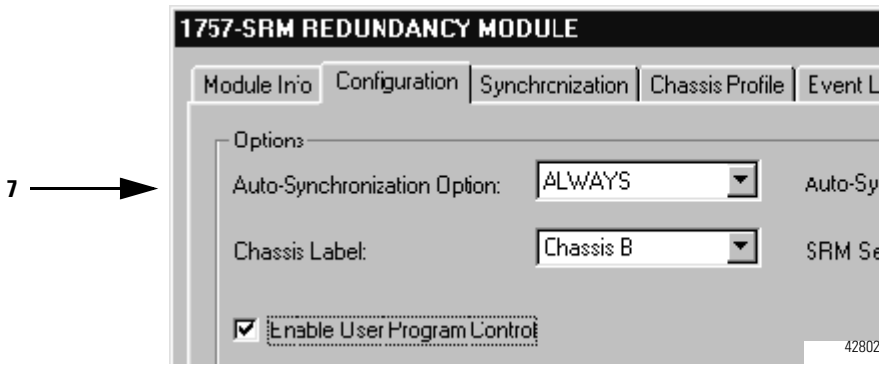
3. Expand the CNB module of the primary chassis.

4. Expand the backplane.



5. Right-click the 1757-SRM module and select *Properties*.

6. Click the *Configuration* tab.



7. Select *ALWAYS*.

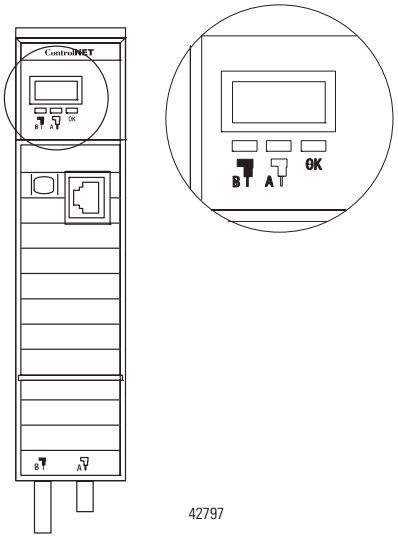
8. Choose *OK*.

Synchronize the Controllers

1. Turn on the chassis power to the partner (secondary) chassis.

2. Wait for the 1757-SRM module to complete its power-up cycle. This may take one or two minutes.

3. In the primary chassis, does the CNB module display *PwQS* ?



If:	Then:
yes	The redundant chassis are synchronized. Go to Configure the Project for the Controllers.
no	The redundant chassis are not synchronized. Go to step 4.

4. In the secondary chassis, what does the CNB module display?

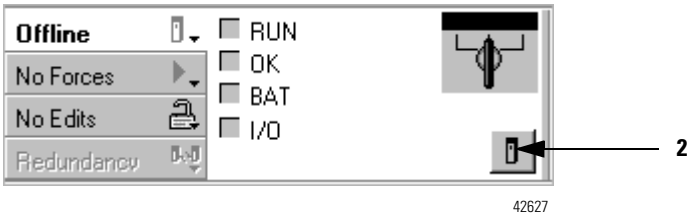
If:	Then check the following:
!cpt	A. All CNB modules in each redundant chassis are series D modules. B. Each CNB module has a partner in the same slot in the other redundant chassis. C. Each pair of CNB modules (one in each chassis) is set to the same node address. D. All CNB modules in each redundant chassis are valid keepers. See "Update a Keeper Signature" on page 5-10.
CMPT	A. Each module has a partner in the same slot in the other redundant chassis. B. Each pair of controllers (one in each chassis) has the same memory board (e.g., 1756-L55M14). C. Each module contains compatible firmware.
DUPL NODE	A. No other device on the ControlNet network is set to the address of the CNB modules *plus one*. For example, if the CNB modules are set to 3, no other device should be set to 4. B. The 1756-SRCx cable is connected to both SRM modules.
NET ERR	All ControlNet taps, connectors, and terminators are connected.

5. Go to step 3.

Configure the Project for the Controllers

In this step, you configure the project for your controller.

1. Open or create the RSLogix 5000™ project.

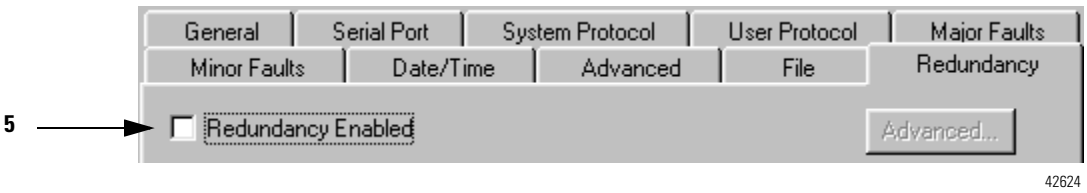


2. On the Online toolbar, click the controller button.

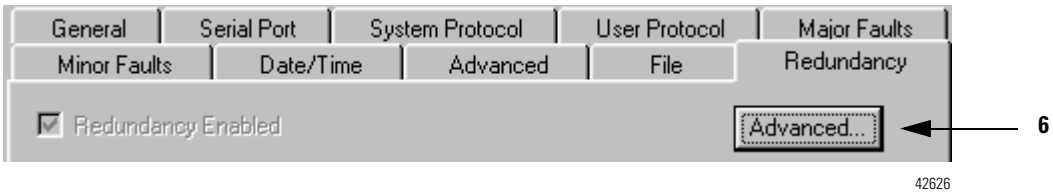
3. Does the *General* tab show that the controller type is a 1756-L55 controller?

If:	Then:
No	A. Click the *Change Type* button. B. Select a 1756-L55 controller. C. Choose *OK*.
Yes	Go to step 4.

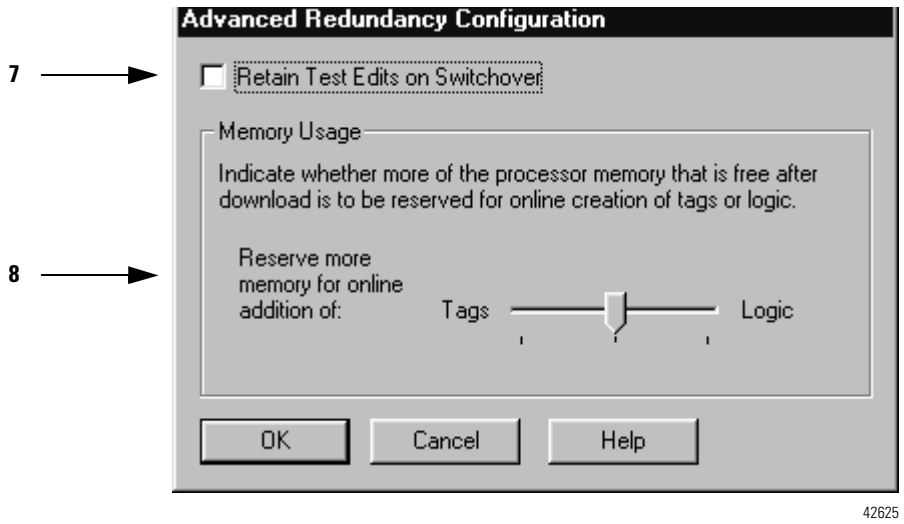
4. Click the *Redundancy* tab.



5. Select the *Redundancy Enabled* check box.



6. Click the *Advanced* button.



7. We recommend that you leave this check box cleared (unchecked). This prevents an incorrect online edit from faulting both the primary and secondary controller.

If you want any test edits to remain active during a switchover (at the risk of faulting both controllers), then check this check box.

8. For online editing, how to you want to reserve any free memory?

If:	Then:
equally between data and logic	Leave the default setting.
more for data and less for logic	Drag to slider toward *Tags*.
less for data and more for logic	Drag to slider toward *Logic*.

9. Choose *OK*.

10. To close the Controller Properties dialog box, choose *OK*.

Configure I/O

In this step, you configure the communications between the controller and its I/O modules.

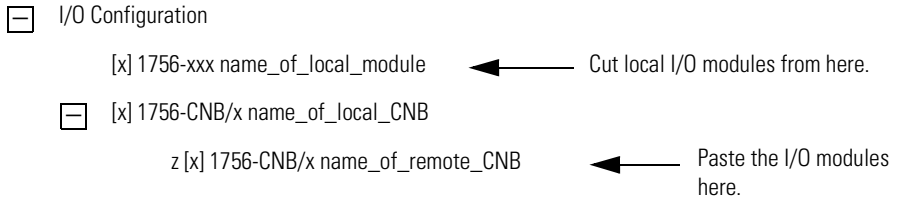
IMPORTANT For each module in your system, make sure that the requested packet interval (RPI) is less than or equal to 375 milliseconds. If you use a larger RPI, the controller could lose its connection with the module during a switchover. This could cause outputs to change state.

Determine where to start:

If you are:	And the system:	Then:
converting an existing system to a redundant system	contained only remote I/O modules	You do not have to change the I/O configuration of the controller. Go to "Test and Tune the System" on page 4-1.
	contained local I/O modules	Use the procedures in this section to convert the configuration of local modules to remote modules: • Re-Configure the Local I/O Modules • Replace Local I/O Tags • Replace any Aliases to Local I/O Tags
configuring a new system for redundancy	→	Configure the I/O. See the *ControlLogix System User Manual,* publication 1756-UM001.

Re-Configure the Local I/O Modules

1. If you have not already done so, add the CNB module of the remote chassis to the I/O configuration of the controller. See the *ControlLogix System User Manual*, publication 1756-UM001.



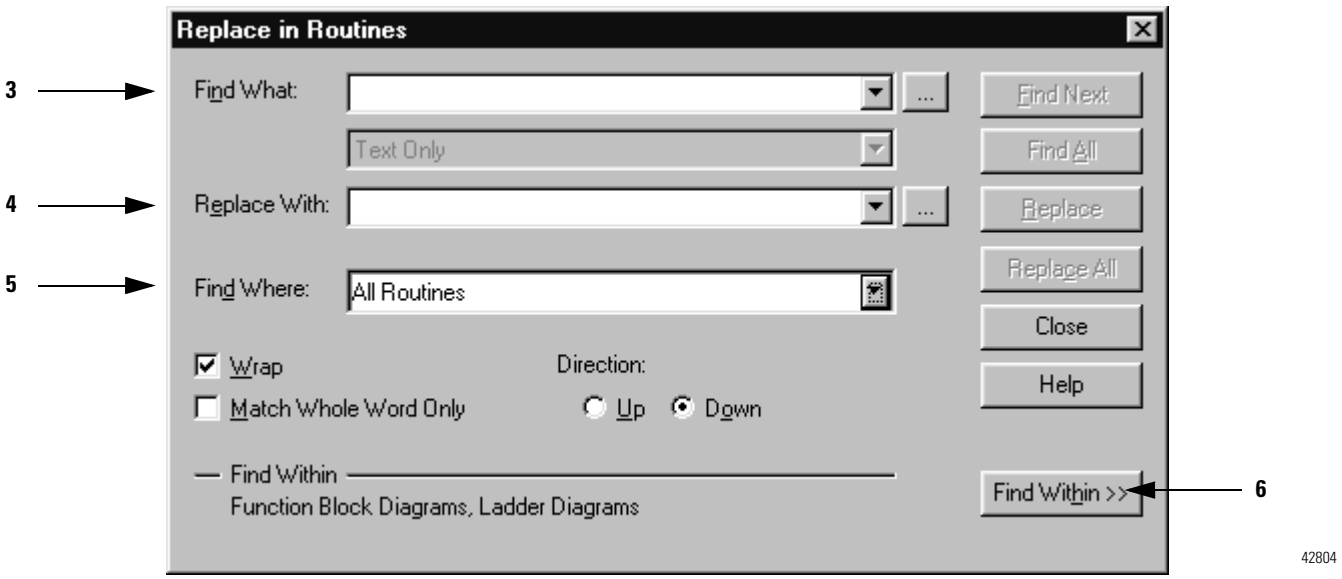
2. In the controller organizer, cut the modules from the local I/O configuration and paste them into the remote CNB module. Cut and paste the following modules:
   - I/O
   - 1756-DHRIO

- 1756-DNB
- 1756-ENET or -ENB
- 1756-MVI

Replace Local I/O Tags

1. Open a routine. If a routine is already open, click within the routine to activate the window.

2. Press the *Ctrl* + *H* keys (replace).

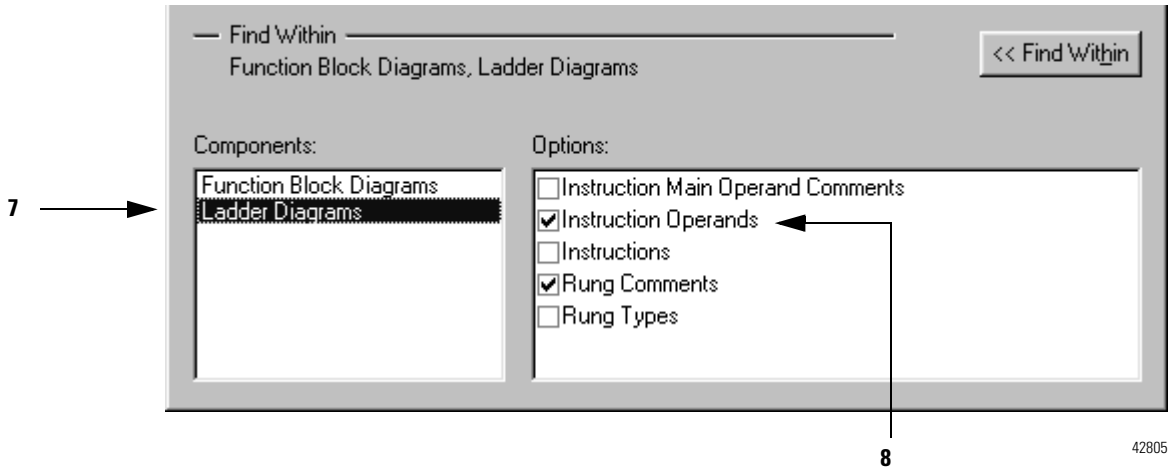


3. Type *Local*.

4. Type the name of the CNB module that is in the remote chassis.

5. Select *All Routines*.

6. Choose *Find Within* >>.



7. Select *Ladder Diagram*.

8. Check *Instruction Operands*.

9. Choose *Replace All*.

The Search Results tab displays the changes to the logic.

10. Choose *Close*.

The following example shows the results of replacing “Local” with “chassis_c”.

EXAMPLE

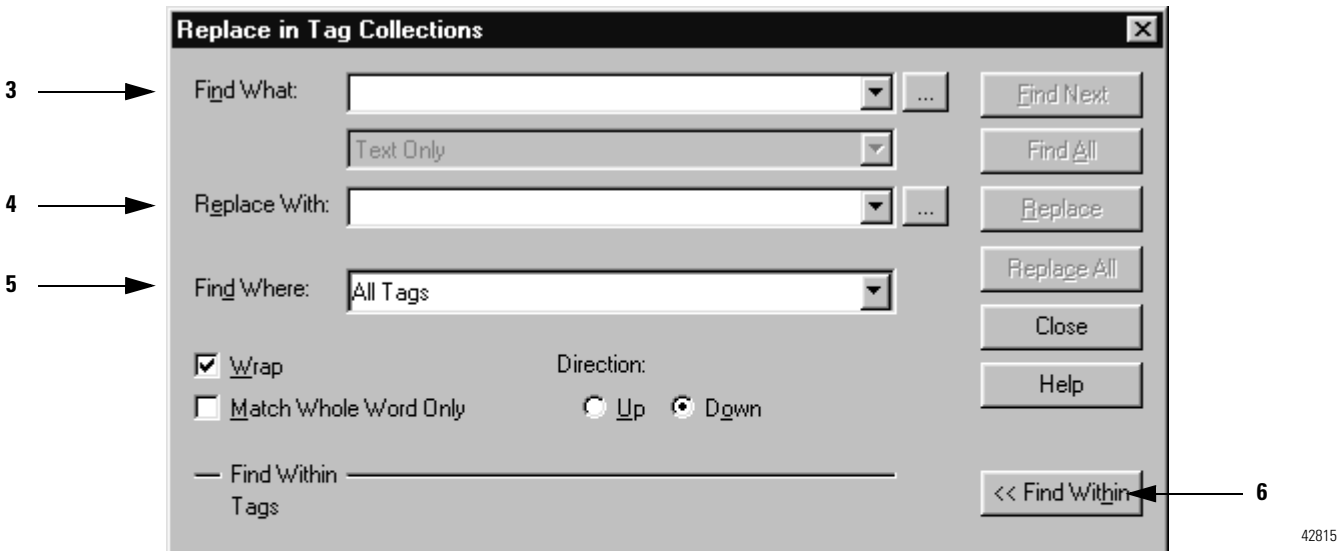
```
Replacing "Local" with "chassis_c"...

Searching through MainProgram - MainRoutine...
Replaced: Rung 0, XIC, Operand 0: XIC(Local:16:I.Data.0)
Replaced: Rung 0, OTE, Operand 0: OTE(Local:2:O.Data.0)
Replaced: Rung 1, XIC, Operand 0: XIC(Local:16:I.Data.1)
Replaced: Rung 1, OTE, Operand 0: OTE(Local:2:O.Data.1)
Replaced: Rung 2, XIC, Operand 0: XIC(Local:16:I.Data.2)
Replaced: Rung 2, OTE, Operand 0: OTE(Local:2:O.Data.2)
Replaced: Rung 8, OTE, Operand 0: OTE(Local:15:O.CommandRegister.Run)

Complete - 7 occurrence(s) found, 7 occurrence(s) replaced.
```

Replace any Aliases to Local I/O Tags

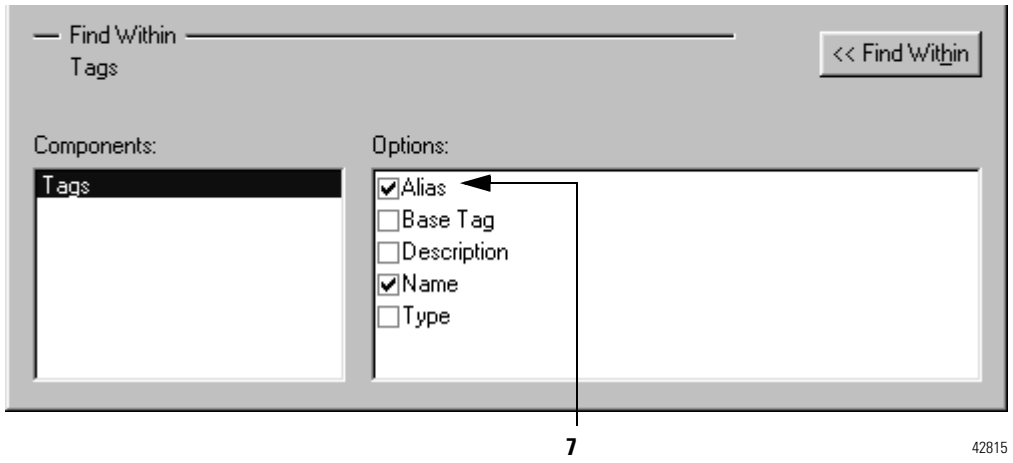
Are any of your tags an alias for an I/O device that was previously in a local chassis?

If:	Then:
Yes	Go to step 1.
No	Skip this procedure.

1. From the *Logic* menu, choose *Edit Tags*.
2. Press the *Ctrl* + *H* keys (replace).



3. Type *Local*.
4. Type the name of the CNB module that is in the remote chassis.
5. Select *All Tags*.
6. Choose *Find Within* >>.



7. Check *Alias*.

8. Choose *Replace All*.

9. Choose *Close*.

Tips for Configuring Your System

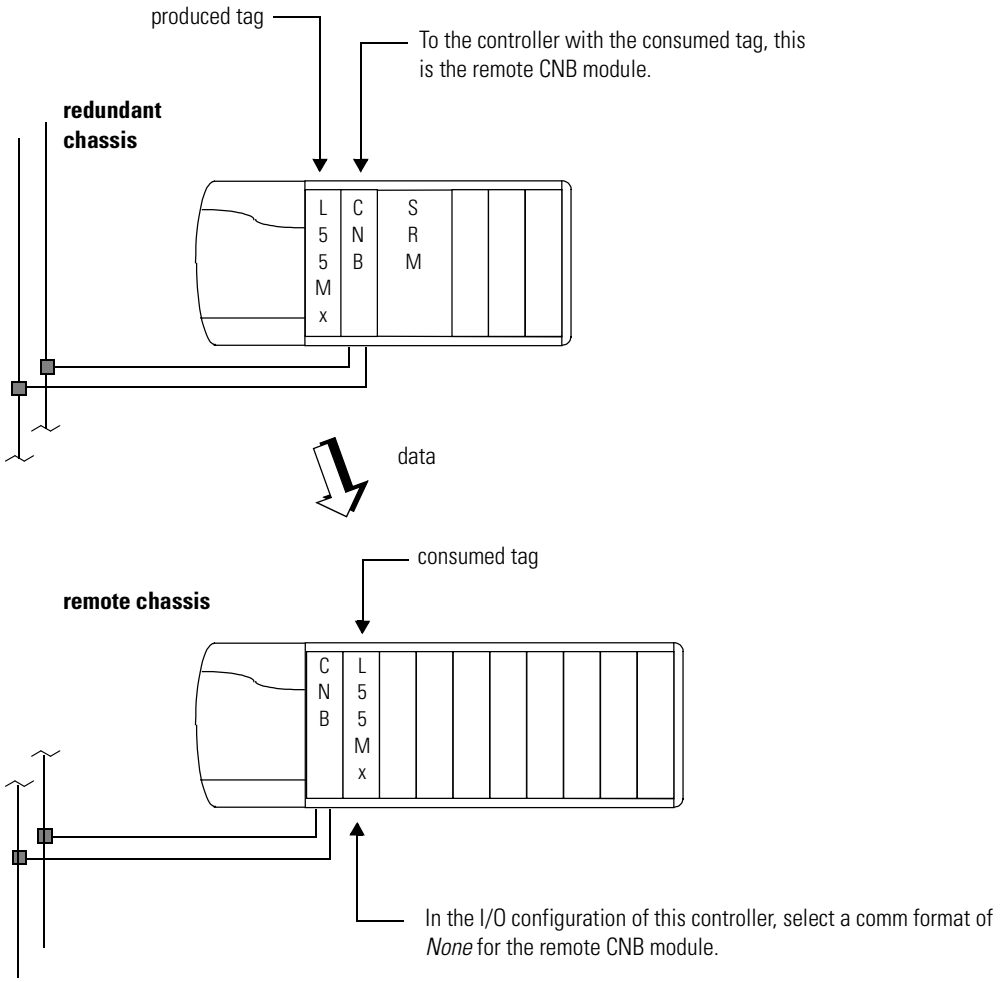
- For any outputs that require a bumpless switchover:
  - Put those outputs in the highest priority task.
  - Configure only that task at the highest priority.

IMPORTANT During a switchover, the connection for tags that are consumed *from* a redundant controller may time out.

- The data *does not* update.
- The logic acts on the last data that it received.

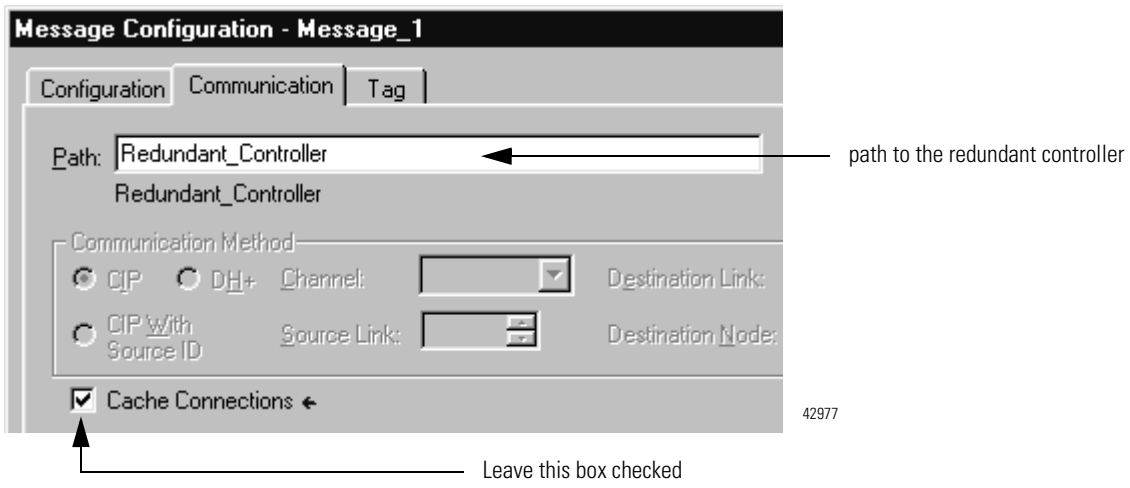
After the switchover, the connection reestablishes and the data begins to update again.

- If you want a controller in another chassis to consume a tag from the redundant controller, use a comm form of *None*. In the I/O configuration of the consuming controller, select a comm format of *None* for the remote CNB module (the CNB that is physically in the redundant chassis).


produced tag
To the controller with the consumed tag, this is the remote CNB module.
redundant chassis
L 5 5 M x
C N B
S R M
data
consumed tag
remote chassis
C N B
L 5 5 M x
In the I/O configuration of this controller, select a comm format of None for the remote CNB module.

- For any MSG instruction from a controller in another chassis to a redundant controller, cache the connection:

Properties of the Message to the Redundant Controller



- If you plan to monitor tags directly in the secondary controller (not typical), monitor from no more than 3 devices through a CNB module.

Notes:

Test and Tune the System

When to Use this Chapter

After you configure your system, use this chapter to make sure that your system switches control as required.

How to Use this Chapter

To test and tune the system:

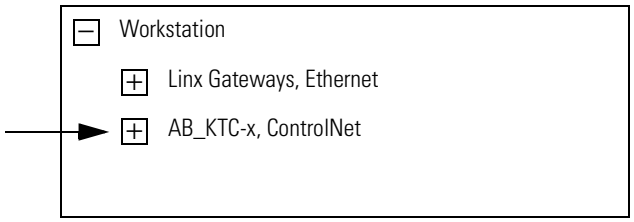
- Download the Project to the Primary Controller
- Select a Network Update Time
- Schedule the Network
- Test the Switchover
- Adjust CNB Usage
- Estimate the Switchover Time

Download the Project to the Primary Controller

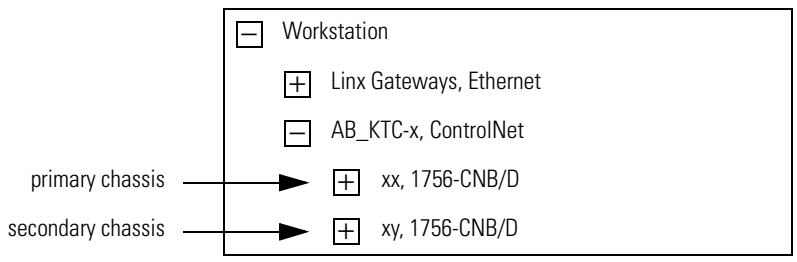
1. In RSLogix 5000 software, from the *File* menu, choose *Save*.
2. From the *Communications* menu, choose *Who Active*.

To expand a network one level, do one of the following:

- Double-click the network.
- Select the network and press the → key.
- Click the + sign.

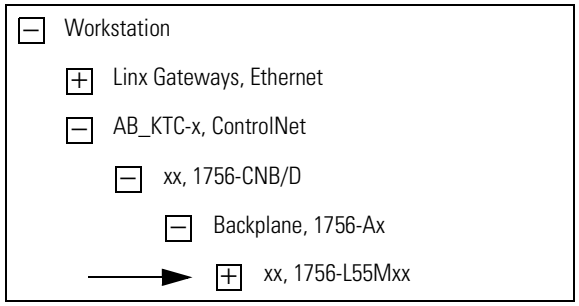


3. Navigate to the CNB module of the primary chassis. The primary chassis uses the node to which its rotary switches are set.



4. Expand the CNB module of the primary chassis.

5. Expand the backplane.



6. Select the controller and choose *Download*.

A confirmation box opens.

7. Choose *Download*.

You *do not* have to download the project to the secondary controller. When the secondary controller is synchronized, the system automatically transfers the project to the secondary controller.

Select a Network Update Time

Use a network update time (NUT) that is less than or equal to the following values.

If you have:	And:	Then:
only one CNB module in a redundant chassis	→	Use a NUT that is less than or equal to 90 milliseconds.
more than one CNB module in a redundant chassis	the CNB modules are on the same network	Use a NUT that is less than or equal to 90 milliseconds.
	the CNB modules are on different networks	The NUT of each network must be within the values indicated in Table 4.1.

If you use a larger NUT, the controller could lose its connection with a module during a switchover. This could cause outputs to change state.

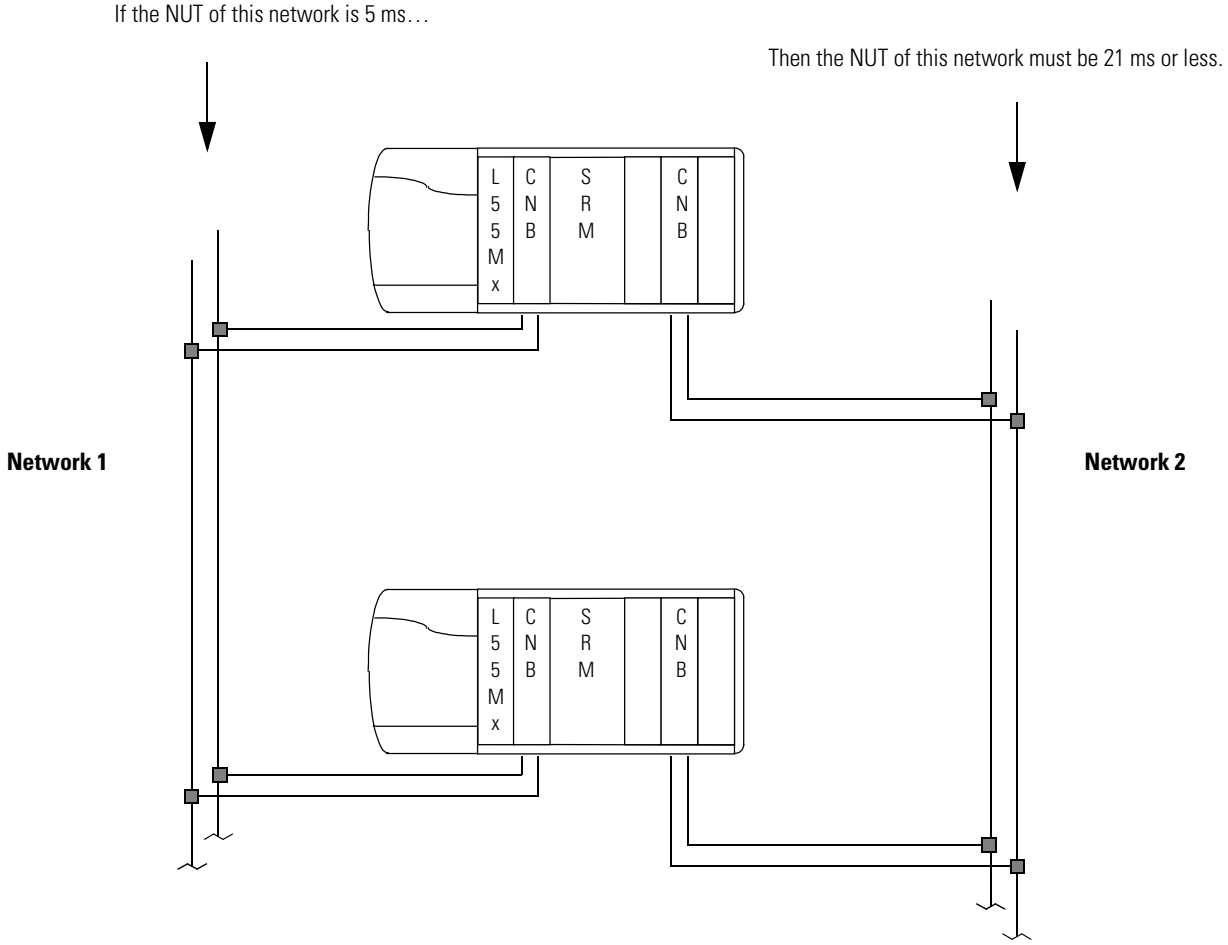
Table 4.1 NUTs for multiple ControlNet networks

If the smallest NUT on a network is (ms):	Then the largest NUT on any other network must be less than or equal to (ms):
2	15
3	17
4	19
5	21
6	23
7	25
8	27
9	29
10	31
11	33
12	35
13	37
14	39
15	41
16	43
17	46
18	48
19	50

Table 4.1 NUTs for multiple ControlNet networks (Continued)

If the smallest NUT on a network is (ms):	Then the largest NUT on any other network must be less than or equal to (ms):
20	52
21	55
22	57
23	59
24	62
25	64
26	66
27	68
28	71
29	73
30	75
31	78
32	80
33	82
34	84
35	87
36	89
37 - 90	90

EXAMPLE Network Update Times for Multiple ControlNet Networks



Schedule the Network

Use the following procedures to schedule your network:

- Schedule a New Network
- Update the Schedule of an Existing Network

Schedule a New Network

1. Turn on the power to each chassis.
2. Start RSNetworx™ for ControlNet software.
3. From the *File* menu, choose *New*.
4. From the *Network* menu, choose *Online*.
5. Select your ControlNet network and choose *OK*.
6. Select the *Edits Enabled* check box.
7. From the *Network* menu, choose *Properties*.
8. From the *Network Parameters* tab, type or select the following parameters:

In this box:	Specify:
Network Update Time	repetitive time interval in which data is sent over the ControlNet network
Max Scheduled Address	greatest node number to use scheduled communications on the network
Max Unscheduled Address	greatest node number that you will use on the network
Media Redundancy	channels in use
Network Name	name for the network

9. choose *OK*.
10. From the *Network* menu, choose *Single Pass Browse*.
11. From the *File* menu, choose *Save*.
12. Type a name for the file that stores the network configuration, then choose *Save*.
13. Select the *Optimize and re-write Schedule for all Connections* button (default) and choose *OK*.
14. In RSLogix 5000 software, save the online project.

Update the Schedule of an Existing Network

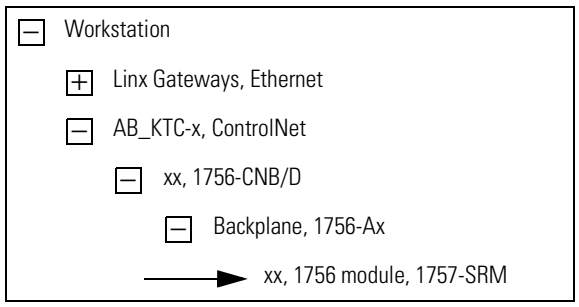
1. Turn on the power to each chassis.
2. Start RSNetworx™ for ControlNet software.
3. From the *File* menu, choose *Open*.
4. Select the file for the network and choose *Open*.
5. From the *Network* menu, choose *Online*.
6. Select the *Edits Enabled* check box.
7. From the *Network* menu, choose *Properties*.
8. From the *Network Parameters* tab, update the following parameters:

In this box:	Specify:
Max Scheduled Address	greatest node number to use scheduled communications on the network
Max Unscheduled Address	greatest node number that you will use on the network

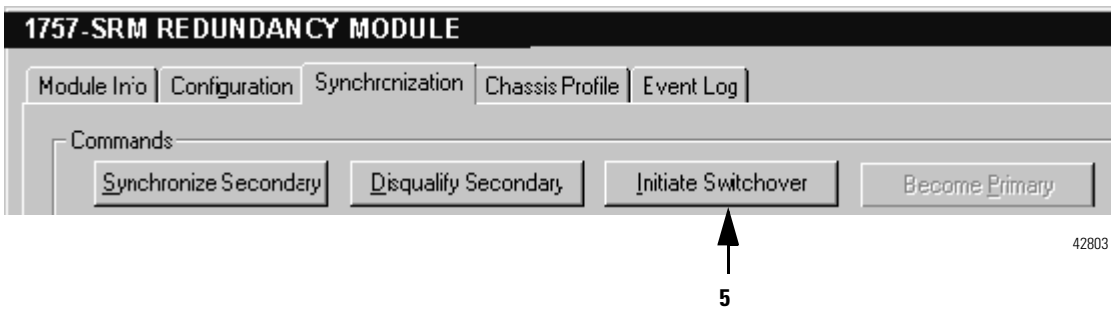
9. choose *OK*.
10. From the *Network* menu, choose *Single Pass Browse*.
11. From the *File* menu, choose *Save*.
12. Select the *Optimize and re-write Schedule for all Connections* button (default) and choose *OK*.
13. In RSLogix 5000 software, save the online project.

Test the Switchover

1. Display RSLinx software.
2. Expand the network until you see the 1757-SRM module in the primary chassis.



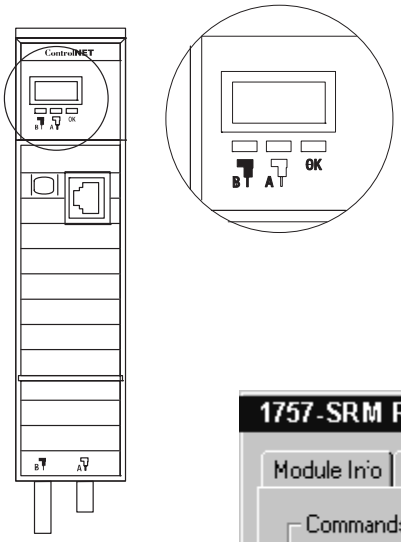
3. Right-click the 1757-SRM module and select *Properties*.
4. Click the *Synchronization* tab.



5. Choose *Initiate Switchover*.
6. Choose *Yes* to confirm the switchover.

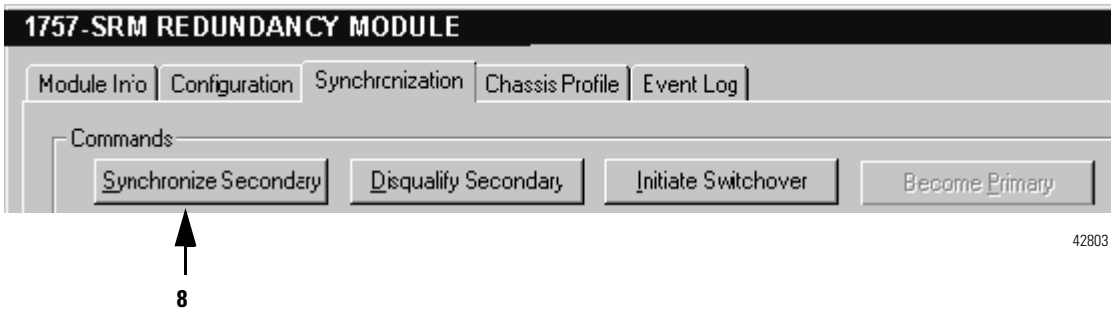
   The CNB module (s) in the new primary chassis display a sequence of status messages. Typically, the module (s) displays the following sequence:

PwNS ⇒	*PwDS* ⇒	*PwQg* ⇒	*PwQS*
primary with no secondary	primary with disqualified secondary	primary with qualifying secondary	primary with qualified secondary



7. In the primary chassis, what does the CNB module display?

If:	Then:
PwQS	The switchover was successful and the redundancy system functions correctly. • In the 1757-SRM properties, choose *OK*. • Skip the remaining steps in this task.
PwDS	The switchover occurred but the secondary controller (s) did not synchronize. Go to step 8.



8. Choose *Synchronize Secondary*.

9. Choose *Yes* to confirm.

If the controller contains a large project, the system may spend some time qualifying the secondary controller. During this time, the CNB module in the primary chassis will display *PwQg*.

10. In the primary chassis, does the CNB module display *PwQS* ?

If:	Then:
Yes	The secondary controller is synchronized. • In the 1757-SRM properties, choose *OK*. • Skip the remaining steps in this task.
No	Go to step 11.

11. Cycle power to the secondary chassis.

12. If the CNB module in the primary chassis fails to display *PwQS,* contact your Rockwell Automation representative or local distributor.

Adjust CNB Usage

For each CNB module in a redundant chassis, we recommend that you keep CPU usage to less than 75 percent.

- Each redundant CNB module needs enough additional processing time for redundancy operations.
- At peak operations such as qualification, redundancy uses an additional 8 percent (approximately) of the CPU of the CNB module.
- A total CPU usage that is higher than 75 percent may prevent a secondary chassis from qualifying after a switchover.

To keep CPU usage of the CNB modules within the recommended limit:

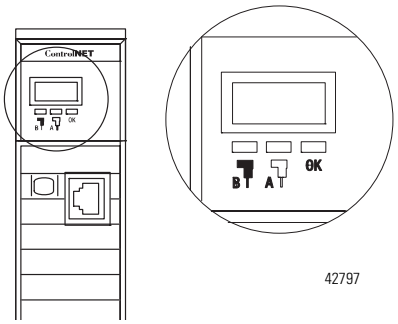
- Get the CPU Usage of a CNB Module
- Reduce the CPU Usage of a CNB Module

Get the CPU Usage of a CNB Module

To get the CPU usage of a CNB module, you have these options:

- Four Character Display
- RSLinx Software
- Message Instruction

Four Character Display



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On the front of the 1756-CNB/D or -CNBR/D module, the four character display shows the CPU usage of the module The display shows the usage in this format:

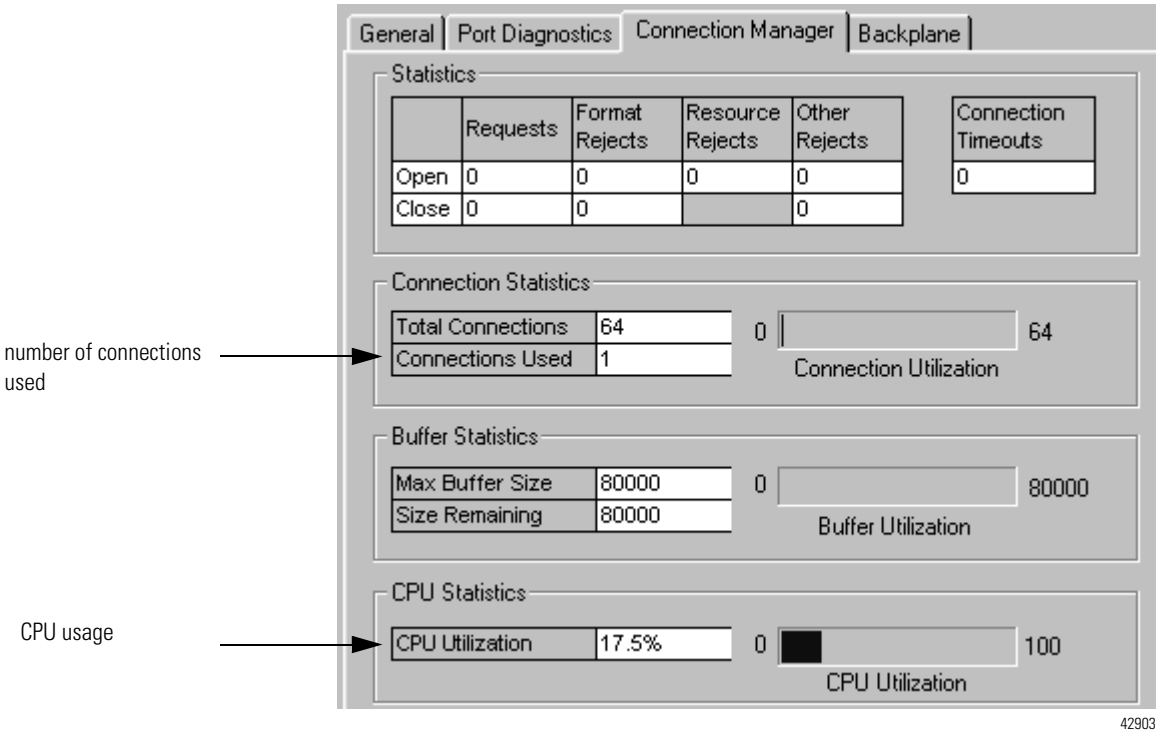
%Cxx

where:

xx is the percent of CPU usage. The range for the display is 00 - 99 %.

RSLinx Software

1. Start RSLinx software.
2. Expand a network until you see your CNB module.
3. Right-click the module and choose *Module Statistics*.
4. Click the *Connection Manager* tab.



Message Instruction

See “Send a Message to a Module” on page 5-5.

Reduce the CPU Usage of a CNB Module

To reduce the CPU usage of a module, you have these options:

- Change the network update time (NUT) of the ControlNet network (Typically, increase the NUT to reduce the CPU usage of a CNB module.)
- Increase the requested packet interval (RPI) of your connections
- Reduce the number of connections to (through) the CNB
- Reduce the number of MSG instructions
- Add another CNB module to each redundant chassis

Estimate the Switchover Time

The switchover time of a redundant system depends on the network update time (NUT) of the ControlNet network. To estimate the switchover time, use the following formulas:

For this type of failure:	The switchover time is:	Example:
loss of power	5 (*NUT*) + MAX (2 (*NUT*), 30)	For a NUT of 10 ms, the switchover time is approximately 80 ms.
module fails		
CNB module cannot communicate with any other node	14 (*NUT*) + MAX (2 (*NUT*), 30) + 50	For a NUT of 10 ms, the switchover time is approximately 220 ms.

where:

NUT is the network update time of the network.

Notes:

Maintain and Troubleshoot the System

When to Use this Chapter

This chapter provides a variety of procedures to assist as you commission and operate your redundancy system.

How to Use this Chapter

If you want to:	Then see this section:	Which starts on page:
use ladder logic to get system or status information about your redundancy system	Get System Values	5-1
use ladder logic to initiate a redundancy action, such as synchronize the secondary controller	Send a Message to a Module	5-5
update the keeper signature of a CNB module because either: • The module was off when you scheduled the network. • The module was previously used in a different system.	Update a Keeper Signature	5-10
change the revision of a module while minimizing the time your system is off	Update a Module	5-13
diagnose the cause of an unplanned switchover	Determine the Cause of a Switchover	5-17

Get System Values

You can use a GSV instruction in your ladder logic to get system values for your redundancy system. You can then display that information on an HMI screen.

The REDUNDANCY object provides the following status information about the redundancy system.

Attribute:	Data Type:	Instruction:	Description:	
ChassisRedundancyState	INT	GSV	redundancy status of the entire chassis	
			If:	**Then:**
			16#1	power-up or undetermined
			16#2	primary with qualified secondary
			16#3	primary with disqualified secondary
			16#4	primary with no secondary

Attribute:	Data Type:	Instruction:	Description:	
CompatibilityResults	INT	GSV	results of the compatibility checks with the partner controller	
			If:	**Then:**
			0	undetermined
			1	no compatible partner
			2	fully compatible partner
KeyswitchAlarm	DINT	GSV	keyswitch settings of the controller and its partner match or do not match	
			If:	**Then:**
			0	one of the following: • The keyswitches match. • No partner is present.
			1	keyswitches do not match
ModuleRedundancyState	INT	GSV	redundancy status of the controller	
			If:	**Then:**
			16#1	power-up or undetermined
			16#2	primary with qualified secondary
			16#3	primary with disqualified secondary
			16#4	primary with no secondary
			16#6	primary with qualifying secondary
PartnerChassisRedundancy State	INT	GSV	redundancy state of the partner chassis	
			If:	**Then:**
			16#8	qualified secondary
			16#9	disqualified secondary with primary
PartnerKeyswitch	DINT	GSV	position of the keyswitch of the partner	
			If:	**Then the keyswitch is in:**
			0	unknown
			1	RUN
			2	PROG
			3	REM
PartnerMinorFaults	DINT	GSV	status of the minor faults of the partner (if the ModuleRedundancyState indicates that a partner is present)	
			This bit:	**Means this minor fault:**
			4	problem with an instruction (program)
			6	periodic task overlap (watchdog)
			9	problem with the serial port
			10	low battery

Attribute:	Data Type:	Instruction:	Description:	
PartnerMode	DINT	GSV	mode of the partner	
			If:	**Then:**
			16#0	power up
			16#1	program
			16#2	run
			16#3	test
			16#4	faulted
			16#5	run-to-program
			16#6	test-to-program
			16#7	program-to-run
			16#8	test-to-run
			16#9	run-to-test
			16#A	program-to-test
			16#B	into faulted
			16#C	faulted-to-program
PartnerModuleRedundancy State	INT	GSV	redundancy state of the partner	
			If:	**Then:**
			16#7	qualifying secondary
			16#8	qualified secondary
			16#9	disqualified secondary with primary
PhysicalChassisID	INT	GSV	In a pair of redundant chassis, identification of a specific chassis without regard to the state of the chassis.	
			If:	**Then:**
			0	unknown
			1	Chassis A
			2	Chassis B
QualificationInProgress	INT	GSV	status of the qualification process	
			If:	**Then:**
			-1	Qualification is not in progress.
			0	unsupported
			1 - 99	For modules that can measure their completion percentage, the percent of qualification that is complete.
			50	For modules that *cannot* measure their completion percentage, qualification is in progress.
			100	Qualification is complete.
SRMSlotNumber	INT	GSV	slot number of the 1757-SRM module in this chassis	

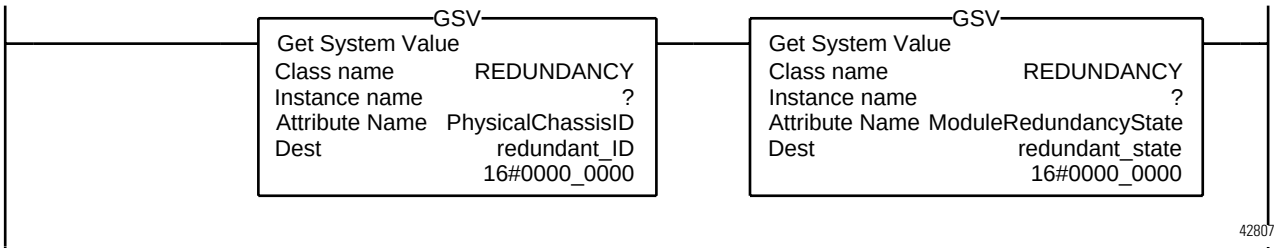
Attribute:	Data Type:	Instruction:	Description:	
LastDataTransferSize	DINT	GSV	This attribute is only valid on a primary controller that is configured for redundancy.	
			If:	**Then this value is the:**
			a synchronized partner is present	amount of data that was last transferred to the partner, specified in DINTs
			no partner is present	amount of data that would have been last transferred to a synchronized partner, specified in DINTs
			a disqualified partner is present	
MaxDataTransferSize	DINT	GSV SSV	Maximum value of the LastDataTransferSize attribute • This attribute is only valid on a primary controller that is configured for redundancy. • To reset this value, use an SSV instruction with a Source value of 0.	

For more information on the status information that you can access with the GSV instruction, see *Logix5000 Controllers General Instructions Reference Manual*, publication 1756-RM003.

EXAMPLE

Get system values

The first GSV instruction gets the label of the chassis that is currently the primary chassis and stores the value in `redundant_ID`. The second GSV instruction gets the redundancy state of the controller and stores the value in `redundant_state`.



Where:	Is:
`redundant_ID`	Tag to store the chassis label. The label tells you which chassis is acting as the primary chassis: • Data type is DINT. • Display style is Hex.
`redundant_state`	Tag to store the value of the redundancy state of the controller: • Data type is DINT. • Display style is Hex.

Send a Message to a Module

You can use ladder logic to perform the following actions:

- initiate a switchover
- disqualify the secondary controller
- synchronize the secondary controller
- set the clock of the SRM module
- get the CPU usage of a CNB module

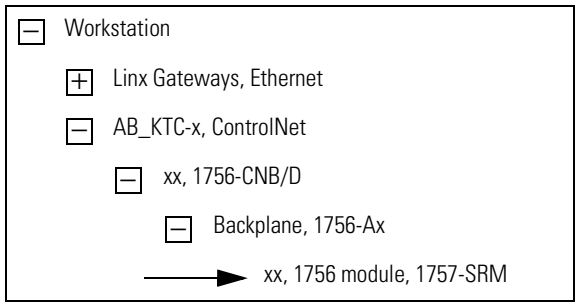
To send a message to a module:

- Configure the 1757-SRM Module
- Enter the Message Instruction
- Configure the Message Instruction

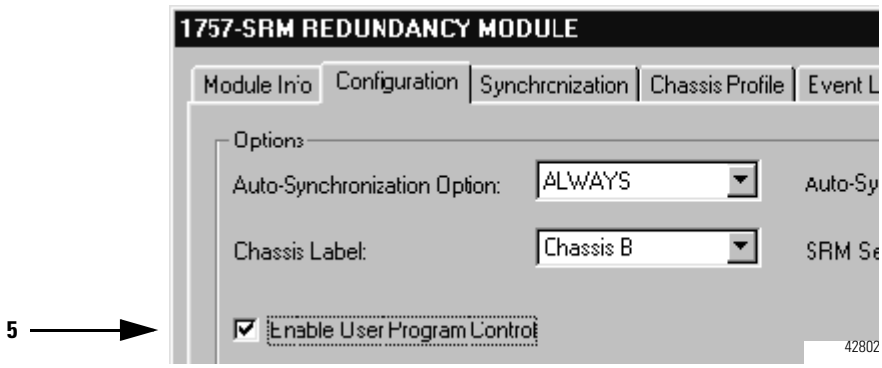
Configure the 1757-SRM Module

To send a message to an 1757-SRM module, configure the module to respond to ladder logic messages:

1. Start RSLinx software.
2. Expand the network until you see the SRM module in the primary chassis.



3. Right-click the 1757-SRM module and select *Properties*.
4. Click the *Configuration* tab.



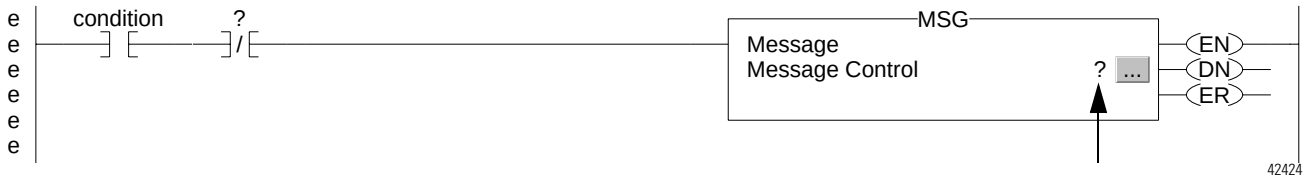
5. Select the *Enable User Program Control* check box. This is the default setting.

6. Choose *OK*.

Enter the Message Instruction

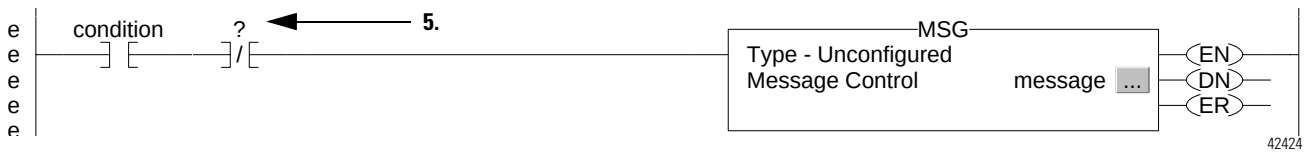
1. Open the RSLogix 5000 project.

2. Enter a MSG instruction and associated input instruction (s).



3. In the MSG instruction, type a name for the message control tag and press the *Enter* key.

4. In the MSG instruction, right-click the message control tag and select *New* `tag_name.`



5. Enter `message.`EN.

   where:

   `message` is the message control tag from step 3.

Configure the Message Instruction

1. In the MSG instruction, click ... .
2. Select a configuration for the message:

Table 5.1 Message to a Module

If you want to:	For this item:	Type or select:
initiate a switchover	Message Type	*CIP Generic*
	Service Code	4e
	Class name	bf
	Instance name	1
	Attribute name	leave blank
	Source	DINT tag with a value of 1
	Num. Of Elements	4
	Destination	leave blank
disqualify the secondary controller	Message Type	*CIP Generic*
	Service Code	4d
	Class name	bf
	Instance name	1
	Attribute name	leave blank
	Source	DINT tag with a value of 1
	Num. Of Elements	4
	Destination	leave blank
synchronize the secondary controller	Message Type	*CIP Generic*
	Service Code	4c
	Class name	bf
	Instance name	1
	Attribute name	leave blank
	Source	DINT tag with a value of 1
	Num. Of Elements	4
	Destination	leave blank

Table 5.1 Message to a Module (Continued)

<table>
<tr><th>If you want to:</th><th>For this item:</th><th>Type or select:</th></tr>
<tr><td rowspan="8">set the clock of the SRM module</td><td>Message Type</td><td>CIP Generic</td></tr>
<tr><td>Service Code</td><td>10</td></tr>
<tr><td>Class name</td><td>8b</td></tr>
<tr><td>Instance name</td><td>1</td></tr>
<tr><td>Attribute name</td><td>1</td></tr>
<tr><td>Source</td><td><code>WallClockTime[0]</code>
where:
<code>WallClockTime</code> is a DINT[2] array that stores the CurrentValue of the WALLCLOCKTIME object.</td></tr>
<tr><td>Num. Of Elements</td><td>8</td></tr>
<tr><td>Destination</td><td>leave blank</td></tr>
<tr><td rowspan="7">get the CPU usage of a CNB module</td><td>Message Type</td><td>CIP Generic</td></tr>
<tr><td>Service Code</td><td>4f</td></tr>
<tr><td>Class name</td><td>a1</td></tr>
<tr><td>Instance name</td><td>8</td></tr>
<tr><td>Attribute name</td><td>leave blank</td></tr>
<tr><td>Source</td><td>tag that uses a user-defined data type:
<table>
<tr><th colspan="2">Members of the data type:</th><th rowspan="2">Tag value:</th></tr>
<tr><th>Name:</th><th>Data type:</th></tr>
<tr><td>offset</td><td>DINT</td><td>0</td></tr>
<tr><td>size_returned</td><td>INT</td><td>2</td></tr>
</table></td></tr>
<tr><td>Num. Of Elements</td><td>6</td></tr>
<tr><td>Destination</td><td>INT tag in which to store the CPU usage of the CNB module (0 - 99%.)</td></tr>
</table>

3. Click the *Communication* tab.

4. In the Path box, type the following path:

   1, *`slot_number`*

   where:

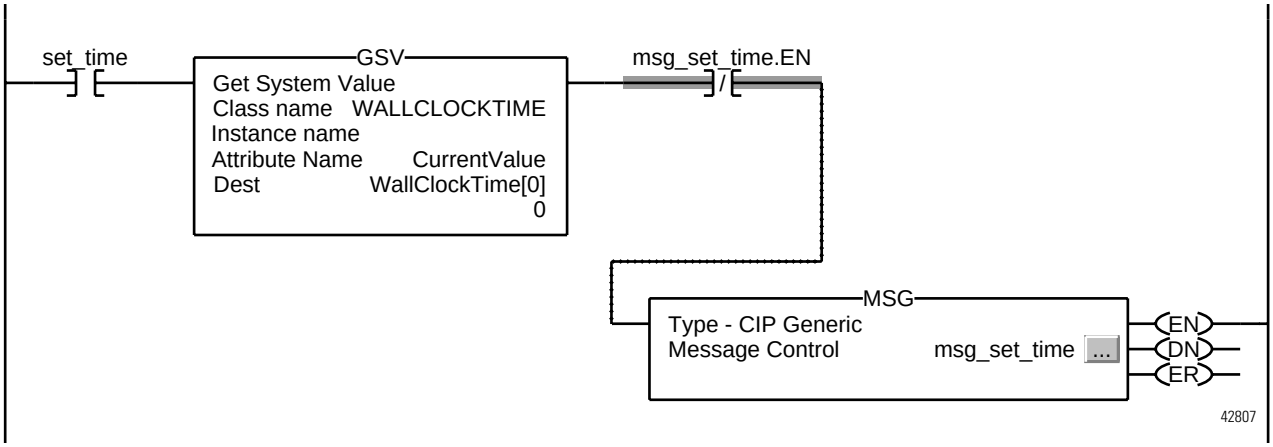
   `slot_number` is the slot number of the module. For a 1757-SRM module, use the left-hand slot number of the module.

5. Choose *OK*.

EXAMPLE

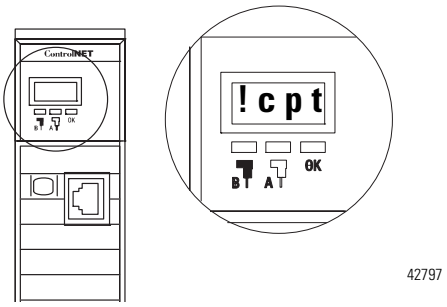
Set the clock of the 1757-SRM module

When *set_time* is on, the GSV instruction gets the current value of the WALLCLOCKTIME object and stores the value in the *WallClockTime* array (64 bits). The message instruction then sends the value to the SRM module.



Update a Keeper Signature

Secondary



If the secondary chassis fails to qualify, and its CNB module displays */cpt*, the keeper signature of a CNB module may not match its partner. This occurs if you schedule the ControlNet network while the secondary chassis is off or if the CNB module was previously configured in a different network.

To update a keeper signature:

- Update Valid Keepers
- Synchronize the Secondary Controller

Update Valid Keepers

1. Start RSNetWorx for ControlNet software.
2. Has this network been scheduled before?

If:	Then:
No	A. From the *File* menu, select *New*. B. From the *Network* menu, select *Online*. C. Select your ControlNet network and choose *OK*.
Yes	A. From the *File* menu, select *Open*. B. Select the file for the network and choose *Open*. C. From the *Network* menu, select *Online*.

3. From the *Network* menu, choose *Keeper Status*.

Keeper Capable Node	Active Keeper	Valid Keeper
offline file	N/A	N/A
01	NO	NO
02	YES	YES

4. In the Valid Keeper column, find a redundant node whose status is *NO*.

5. Select the node and choose *Update Keeper*.

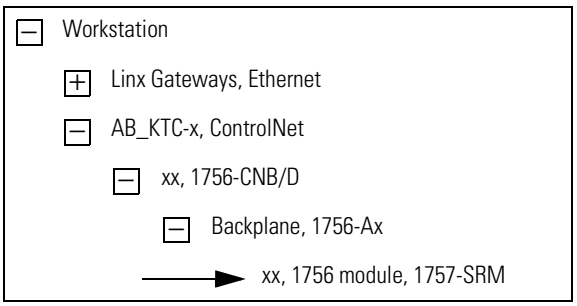
6. Repeat steps 4 and 5 for each redundant CNB module that is not a valid keeper.

7. Choose *Close*.

Synchronize the Secondary Controller

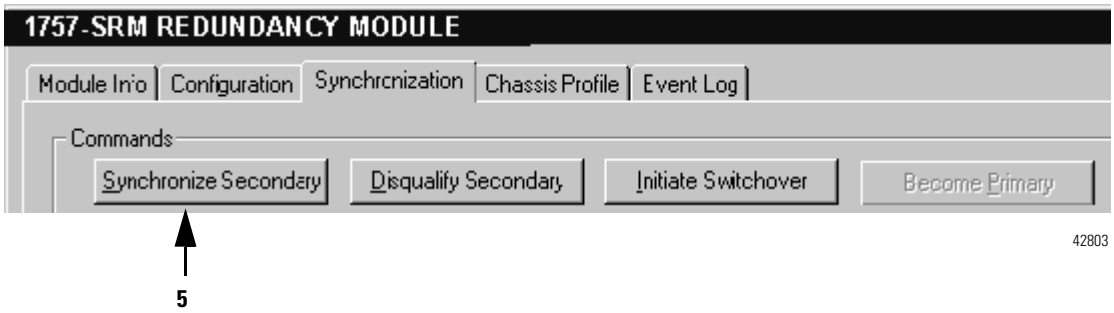
1. Go to RSLinx software.

2. Expand the network until you see the 1757-SRM module in the primary chassis.



3. Right-click the 1757-SRM module and select *Properties*.

4. Click the *Synchronization* tab.



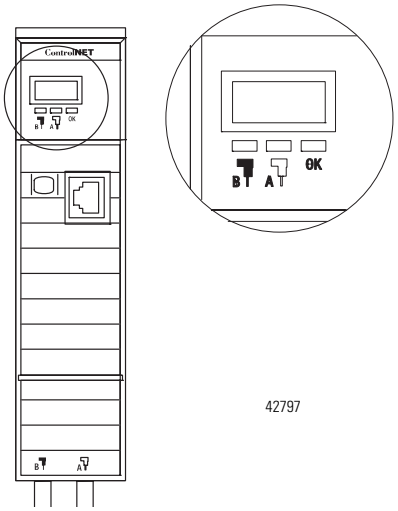
5. Choose *Synchronize Secondary*.

6. Choose *Yes* to confirm.

7. Choose *OK*.

8. In the primary chassis, what does the CNB module display?

Primary



If:	Then:
PwQS	The controller is synchronized.
PwDS	The secondary controller is not synchronized. Go to "Synchronize the Controllers," step 4. on page 3-4.

Update a Module

Use the following steps to upgrade the revision of your redundant modules. This procedure minimizes the time your process is down for the upgrade.

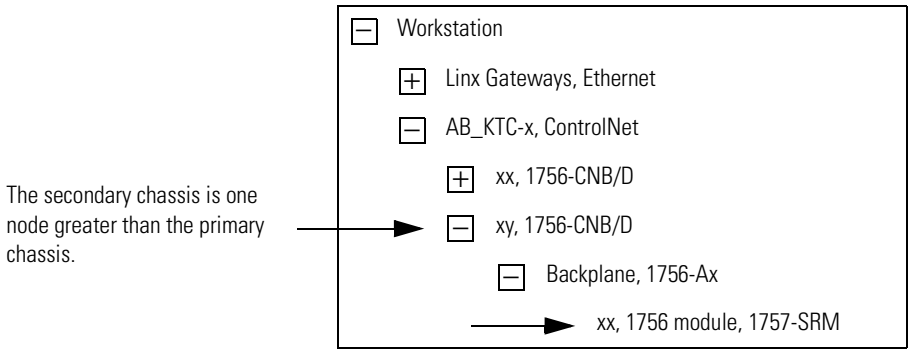
IMPORTANT Do not connect your computer to the ControlNet network via the network access port on a CNB module in the primary chassis. When you turn off power to the chassis, you will lose access to the network.

To update a module:

- Disqualify the Secondary Chassis
- Upgrade the Required Firmware of the Secondary Chassis
- Make the Secondary Controller the New Primary Controller
- Upgrade the Other Redundant Chassis
- Change the Auto-Synchronization Option to ALWAYS

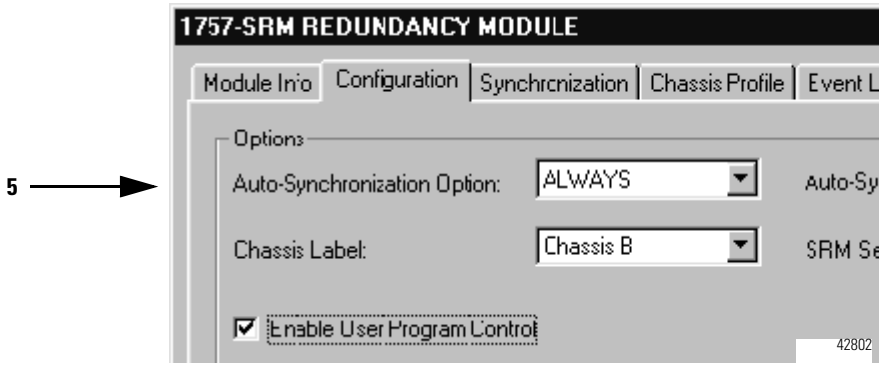
Disqualify the Secondary Chassis

1. Start RSLinx software.
2. Find the SRM module in the secondary chassis.



3. Right-click the 1757-SRM module and select *Properties*.

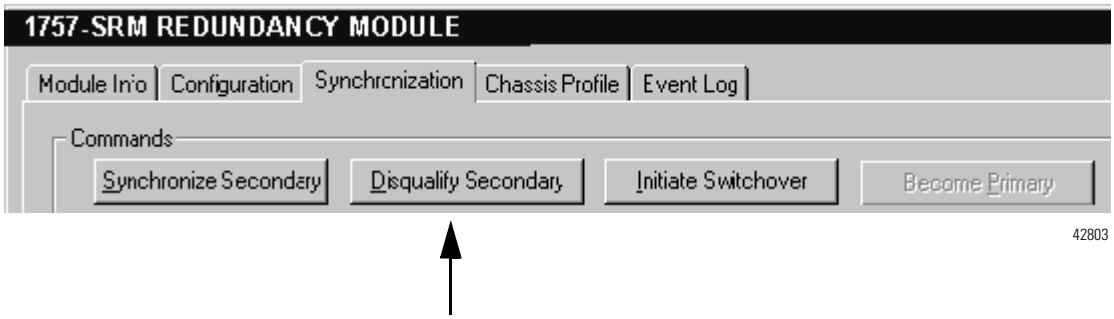
4. Click the *Configuration* tab.



5. Select *NEVER*.

6. Choose *Apply*.

7. Click the *Synchronization* tab.



8. Choose *Disqualify Secondary*.

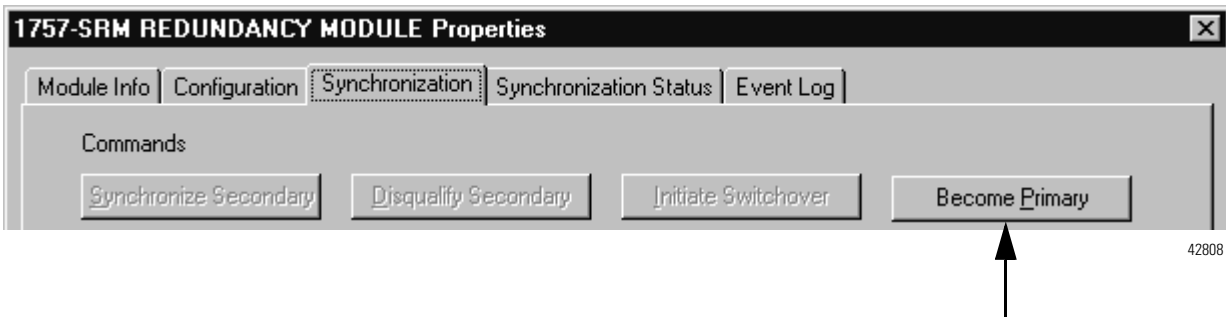
9. Choose *Yes* to confirm.

Upgrade the Required Firmware of the Secondary Chassis

See the*ControlLogix Controller and Memory Board Installation Instructions*, publication 1756-IN101.

Make the Secondary Controller the New Primary Controller

1. Start RSLogix 5000 software.
2. Download the project to the secondary controller.
3. When it is safe to stop the control of your system, change the primary controller to Program Mode.
4. Turn off power to the primary chassis.
5. Go to the 1757-SRM properties of the secondary chassis.



6. Choose *Become Primary*.
7. In RSLogix 5000 software, go online to the new primary controller.
8. The controller is faulted. When a disqualified secondary controller becomes a primary controller, the controller experiences a major fault.
9. From the *Communications* menu, choose *Clear Faults*.
10. To start control of the process, from the *Communications* menu, choose *Run Mode*.

Upgrade the Other Redundant Chassis

1. Turn on power to the other redundant chassis.
2. Upgrade the required firmware of the chassis.

Change the Auto-Synchronization Option to *ALWAYS*

1. Go to RSLinx software.
2. Find the SRM module in the primary chassis and open the properties of the module.
3. On the Configuration tab, change the Auto-Synchronization Option to *ALWAYS*.
4. Choose *OK*.

Determine the Cause of a Switchover

If an unplanned switchover occurs, use the following tables to determine the cause of the switchover.

In the primary chassis, what does the CNB module display?

If:	Then:
PwNS	Go to Table 5.2
PwDS	Go to Table 5.3

Table 5.2 If a CNB module displays PwNS, use this table to troubleshoot the secondary chassis.

If the secondary chassis:	And each primary CNB module:	And a secondary CNB module has a:	Then:
has power	has a partner module in the secondary chassis	Red OK LED	Replace the CNB module.
		Green OK LED	Check the 1756-SRC cable for a proper connection.
	does not have a partner module in the secondary chassis	→	Install a CNB module.
does not have power	→		Restore the power.

Table 5.3 If a CNB module displays PwDS, use this table to troubleshoot the secondary chassis.

If the SRM module has a:	And a secondary CNB module:	And a secondary controller has a:	Then:
Green OK LED	does not display *NET ERR*	Flashing Red OK LED	Clear the major fault of the controller.
		Solid Red OK LED	1. Cycle the power to the chassis. 2. If the OK LED remains solid red, replace the controller and flash the controller with the appropriate revision of firmware.
	displays *NET ERR*	→	Check all ControlNet taps, connectors, and terminators for proper connections.
Red OK LED	→		1. Cycle the power to the chassis. 2. If the CNB module in the primary chassis fails to display *PwQS*, contact your Rockwell Automation representative or local distributor.

Notes:

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